

HORTICULTURE

INSTRUCTIONAL-CUM-PRACTICAL MANUAL

Volume I

PLANT PROTECTION

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Project Coordinator



राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
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Foreword

The programme of vocationalization of higher secondary education has been accepted by the country as it holds forth great promise for linking education with the productivity and economic development of the country by providing education for better employability of the youth

In view of the importance of the programme, the NCERT is making an all out effort to provide academic support to the implementing agencies in the States. One of the major contributions of the NCERT is in the field of curriculum development and in the development of model instructional material. The materials are developed through workshops in which experts, subject specialists, employers' representatives, curriculum framers and teachers of the vocational course are involved. These materials are then sent for try-out in schools and feedback is collected through questionnaires and through direct contact. The materials are also sent to experts for comment before they are published.

The present manual on Plant Protection has been developed in the manner described above and is meant for the students studying Horticulture and allied vocations. It is being published for wider dissemination, amongst students and teachers throughout the country. I hope that they will find the manual useful.

I am grateful to all those who have contributed to the development of this manual. I must acknowledge also the immense interest taken by Prof. A.K. Mishra, Head, Department of Vocationalization of Education in inspiring his colleagues in their endeavours to develop instructional materials. Dr. A.K. Dhote, Lecturer, functioned as the Project Coordinator for the development of this title in association with Dr. A.K. Sacheti, Reader. They have my appreciation and thanks for planning, designing and conducting the workshops, for technical editing and for seeing this manual through the press.

Suggestions for improvement of this manual will be welcome.

P.L. MALHOTRA

Director

New Delhi

National Council of Educational
Research and Training

Preface

Ever since the introduction of vocationalization in our school system by several States in our country the paucity of appropriate instructional materials has been felt as one of the major constraints in implementation of the programme and a source of great hardship to pupils offering vocational studies at the higher secondary stage.

The Department of Vocationalization of Education of the National Council of Educational Research and Training, New Delhi has started a modest programme of developing instructional materials of diverse types to fill up this void in all major areas of vocational education. The task is too gigantic to be completed by any single agency but the model materials being developed by us might provide guidance and impetus to the authors and agencies desiring to contribute in this area. These are based on the national guidelines developed by a Working Group of experts constituted by NCERT.

The present manual is on "Plant-Protection in Horticultural Crops" and is common portion of the Horticulture/Vegetables and Fruits/Fruit Preservation and Processing or related courses in a number of States. It contains activities (Practical exercises) to be performed by pupils with simple steps to follow, precautions to be taken and data to be obtained and processed. Each activity is complete with brief theoretical information, objectives, behavioural outcome, evaluation etc. It is hoped that the pupils will find them immensely useful.

The manual has been developed by a group of experts in a workshop held at the university of Agricultural Sciences, Hebbal, Bangalore (Karnataka). The names of the contributors are mentioned elsewhere and their contributions are admirably acknowledged. Our thanks are also due to Dr. P.L. Tandan of IIHR, Bangalore for the pains he took in verifying the authenticity of contents of the manual. Dr. A.K. Sacheti, Reader and Dr. A.K. Dhote, Lecturer, DVE deserve

special thanks for editing and bringing the materials in the present form. The assistance of all the the UAS Behhal, Bangalore, (Karnataka) and Department of Vocationalization of Education, NCERT is also thankfully acknowledged.

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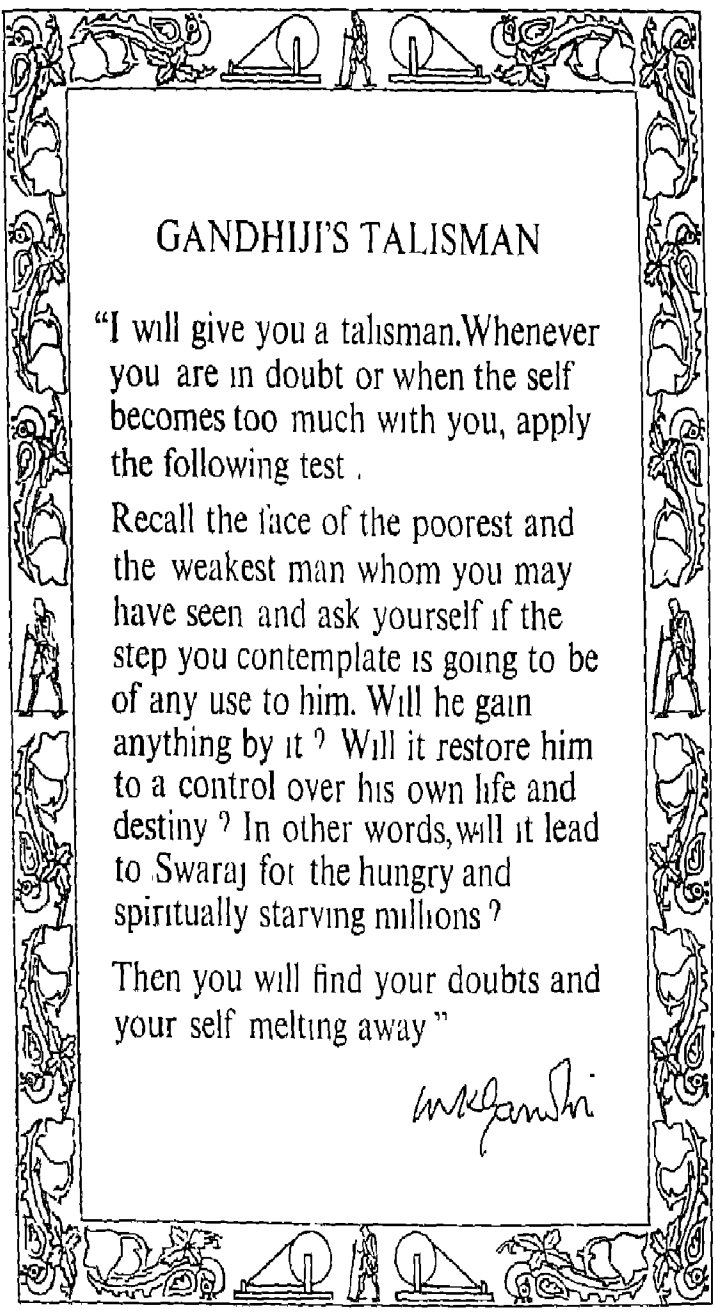
The following experts participated in the workshop conducted by the NCERT. Their participation as contributors or reviewer is gratefully acknowledged.

Contributors

Dr. S.P. Singh, Dr. R.L. Keshwal, Dr. A.K. Sacheti and Dr. A.K. Dhote

Reviewer

Dr. P.L. Tandan



GANDHIJ'S TALISMAN

"I will give you a talisman. Whenever you are in doubt or when the self becomes too much with you, apply the following test .

Recall the face of the poorest and the weakest man whom you may have seen and ask yourself if the step you contemplate is going to be of any use to him. Will he gain anything by it ? Will it restore him to a control over his own life and destiny ? In other words, will it lead to Swaraj for the hungry and spiritually starving millions ?

Then you will find your doubts and your self melting away "

M.K. Gandhi

About the Manual

Under the programme of Vocationalization of Education about 20 different groups of vocational courses in the area of agriculture have been introduced by nine States and three Union Territories so far. These courses have been running for the last six or seven years. From the very beginning the Department of Vocationalization of Education in the NCERT has been working hand in hand with the State organisations concerned through various programmes organised for State officials, vocational teachers, and others. In fact, by now the Department has conducted on-the-spot studies of vocational programme in larger number of States, to find out merits and demerits of the programme and to suggest appropriate measure to resolve the problems in 'vocational agriculture education'. These programmes have revealed that there was a great dearth of suitable textual/instructional materials; the need for practical manuals, especially, was urgently felt. The development of instructional materials and the imparting of practical training become even more important when one considers the purpose for which the vocationalization of education programme has been launched. The main aim of the programme is to prepare the pupil for purposeful and gainful employment (wage-earning or self-employment).

The Department constituted a Working Group during the year 1982 to formulate guidelines for developing models for a variety of instructional materials.

Based on the guidelines formulated by the Working Group, Horticulture, which is an important and popular vocational course in agriculture, was selected by the Department for the purpose of development of instructional materials in a phased manner. To begin with, the development of instructional-cum-practical manuals has been taken up.

The content of Horticulture and similar courses offered by the States and Union Territories under different titles was thoroughly analysed and it was felt that six manuals would be necessary to cater to the needs of the course. The present manual of **Plant Protection in Horticultural Crops** is one of them. This manual is intended to help both teachers and pupils in the study of important pests and diseases of horticultural crops as preparation for this vocation. While developing the manual, care was taken that it should include the maximum number of Activity Units (practical exercise) so that it can fulfil the requirements of the course prescribed by the States and Union Territories in the Horticulture as well as in other vocational courses.

These Activity Units are essential to develop the required vocational skills in the pupils. The manual explains the 'what', and 'how' of these Units.

In the manual each Activity Unit has been dealt with under several sub-heads, viz., instructional objectives, relevant information, precautions, materials required, procedure, observations, expected behavioural outcomes and questions.

Before commencing the actual work under any Activity Unit, the teacher should know what exactly the pupils have to learn and do, and should also assess whether they will be able to do that. Therefore, in the beginning, instructional objectives for the pupils should be framed in behavioural terms by the teacher.

In order to acquaint the pupils with the Activity Unit the teacher should provide them with the required theoretical knowledge or information relevant to the activity. This will help the pupils to properly understand the Activity Unit. In other words, the 'what' and 'why' parts of the Activity Unit should be explained in advance by the teacher.

Once the pupils have understood the relevant theoretical instructions, the teacher should tell them about the precautions which are to be taken before and during the actual execution of the Activity Unit. This will facilitate smooth working. The 'how' part of the Activity should be explained by the teacher in the 'procedure' which pupil should follow while performing the Activity Unit.

Under the sub-head 'observations', the teacher should tell what to observe and in view of that the pupil should observe the situation, take readings, note down the temperature and similar other points under each Unit; these may vary from Unit to Unit. Wherever calculations are required to be done to obtain the results, this should also be indicated under this head or under separate head.

At the end of the Activity the pupil will have acquired certain abilities which should be closely related with the instructional objectives formulated for each Activity Unit. These abilities formulated for each Activity Unit. These abilities should be listed under the sub-head 'expected behavioural outcomes'. Evaluation should be based on the abilities acquired and it should be done by the teacher concerned.

For evaluating each aspect, the teacher will use a four-point scale, i.e., A, B, C & D, and for each Activity Unit the Grade Point Average can be calculated as indicated below.

Suppose there are four aspects, each carrying equal weightage, and a pupil obtains 2A's, 1C and 1D and if A—4 point, B—3, C—2 and D—1 point, then, based on the grades, the pupil will get 11 points. When the number of points obtained is divided by the total number of aspects examined, it will give the Grade Point Average, which, in this case, is 2.75. The tabular presentation is as under.

Aspects	Weightage	Grades Obtained	TOTAL POINTS (weightage x point-equivalent to grade obtained)	Grade Point Average
1	1	A	1 x 4 = 4	× 11/4 = 2.75
2	1	C	1 x 2 = 2	
3	1	D	1 x 1 = 1	
4	1	A	1 x 4 = 4/11	

At the end of the Activity Unit, some questions relevant to it are also given. The pupils should write the appropriate answers after the completion of the Activity Unit and teacher should examine them. If required, he should make suitable corrections and give suggestions. However, answers to these questions will not be considered for the purpose of grading.

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Introduction

Insects, pathogens, weeds, rodents etc pose a serious threat to man in his efforts to derive maximum from raising the crops including the horticultural ones. The menace of insect-pests and diseases is increasing day-to-day with the adoption of new cropping patterns and luxuriant growth of plants induced by the use of fertilizers and irrigation as they create equally favourable conditions for growth of insect-pests in the form of better food material. This holds particularly true in case of horticultural crops, specially the fruit and vegetable crops. It has been estimated that about 20% of the crops is lost every year due to insect-pest and diseases, which, if converted into monetary value, works out to be well over Rs 1,000 crores.

There are several ways to control, if not totally do away with, these losses. The most effective and rational measures are naturally the preventive measures as it is correctly said that prevention is better than cure. Proper and timely cultural operations, use of healthy disease-free seeding materials create conditions not favourable for the growth of plant enemies. The farmer has to be always watchful and vigilant about his crops as keen observations give him plenty of time to take appropriate measures as soon as something undesirable is noticed in the field. Such a contingency will naturally call for proper diagnosis of the disease or identification of pests, insects to be followed by use of appropriate agro-chemicals. For this purpose the farmer should be well conversant with the use of various plant protection equipment. He should also know different agro-chemicals and their formulations used for plant protection purpose. In fact plant protection requires a farmer to be a good entomologist, pathologist, agronomist, farm mechanic as well as economist.

In the present manual we have tried to give details of various insect-pests and diseases, their symptoms, nature of damage, control measures that affect major fruit, vegetable and flower crops. The diseases and insect-pests are given in more details than applicational part of agro-chemicals as their application is done more or less in the same way. However, methods of preparation of working solutions etc. are invariably given with almost every exercise.

We believe that the manual will familiarise the students with a comprehensive picture of the enemies of horticultural crops and will prepare them to combat with them effectively.

Activity Unit: 1

MANAGEMENT OF INSECT-PESTS OF FRUIT CROPS

1.1 Instructional objectives

The pupil should be able to

- identify the common pests,
- understand the nature and extent of damage,
- organise control measures,
- understand the use of application equipment for all the pests.

1.2 Relevant information

(i) Pests of Mango

- (1) *Mango hoppers (Idioscopus spp)* Mango hoppers are widely distributed and are considered serious pests of mango in the country. The adults are small, grey, dark coloured insects

Nature of damage The nymphs and adults suck sap from tender shoots, leaves and inflorescence resulting in wilting and drying of these plant parts. In case of high population, the entire crop may fail. The flower stalks and leaves of the hopper infested trees become sticky due to excretion of honey dew by these insects and sooty mould covers the affected plant parts. The peak activity is confined to flowering season and the loss ranges from 25 to 60 per cent.

Control Spray twice or thrice sevin 50 WP (Carbaryl) at the rate of 3 gms per litre of water. Novacron 40 EC (monocrotophos) 1.25 ml per litre of water at 15 days interval. Spraying should be started at initiation of panicle emergence.

- (2) **Mango mealy bug (*Drosicha mangiferae* Green)** This pest is widely distributed all along the Indo-Gangetic plains of Northern India causing severe damage to the mango orchards. The adult female bugs are flat, oval, waxy white and measure 12-16 mm in size

Nature of damage The eggs are laid in the soil in Ovisac (egg pod). Small pinkish first instar nymphs start hatching in the last week of December and migrate to mango trees. Both nymphs and adult females suck sap from tender shoots and inflorescence resulting in drying of inflorescence and loss in fruit set

Control Remove weeds like Bhatt (*Clerodendrum infloratum*) and other grasses from the orchards and plough the soil during November. In the third week of December in order to kill newly hatched nymphs, 250 gm of aldrin 5% dust should be dusted with hand rotary duster from 30 cm above ground level under the tree in drip circle and then the soil should be raked to ensure that insecticide is mixed. In case of drenching, add 10 ml of aldrin 30 EC per litre of water and prepare about 20 litre emulsion

With the help of water can apply the emulsion to soil around tree trunk. In the last week of December band the trees with 20 cm wide alkathene/polythene (400 gauge). Apply coal tar or fruit tree grease on the lower edge of the band after tying with jute thread to stick it to stem and ensure that the bugs may not climb the tree beneath the band. Banding should be done 50-75 cm above the ground level and just below the junction of branching on all the trees in the orchard including other fruit trees like guava, jack fruit and citrus. In case the bugs have already migrated spray Basudin 20 EC (diazinon) at 3 ml per litre of water or Nuvacron (monocrotophos) 1 ml per litre of water. The spray may be repeated if necessary

- (3) **Oriental Fruitfly (*Dacus dorsalis* Hendel)** : The pest is active throughout the year in South India while in North it hibernates during November to March in pupal stage. Maximum damage to the fruits is done in June-July and late varieties are most susceptible to this pest. The adult is a brown or dark-brown fly with hyaline wings and yellow legs

Nature of damage Fruit flies cause serious loss to mango crop by rendering the fruit unfit for human consumption. The attack of pest starts when the fruits are about to ripen. Maggots after

hatching feed on the fruit pulp and cause complete rotting of the fruits. The damaged fruits have yellow spots with black centres through which liquid oozes out on pressing.

Control The soil should be raked up in summer months in order to expose pupae, parasites and predators to sun. Bait spray with Cythion 50 EC (malathion) @ 1 ml per litre or Sevin 50% WP (carbaryl) @ 4 gms per litre in combination with molasses or jaggery (10 gms per litre of water) should be given twice at fortnightly intervals before the ripening of fruits. A combination of bait sprays and male annihilation technique should be used for effective control of the pest. The technique consists of attracting and killing the male fruit flies in the trap with methyl eugenol 0.1% (1 ml per litre) + Malathion 50 EC 2 ml per litre of water. Put 100 ml emulsion (containing methyl eugenol and malathion) in bottle traps and hang them on mango trees in orchards. The solution should be changed at fortnightly interval from March to July.

The fallen infested fruits should be dumped in 1½ metre deep pit and covered with a thick layer of soil. Mango shoot gall psylla (*Apsylla cistellata* Buchst.) is a serious pest of mango in Tarai region of U.P., Bihar and West Bengal while nut weevil (*Sternonchetus mangiferae* Fabr.) is serious in north-eastern regions and south India.

(ii) Insect pests of citrus

(1) Soft green scale (*Coccus viridis* (Green))

This scale insect is a serious pest of citrus in south India. The adult female is pale green, ovate, slightly convex and measures about 3 mm in length.

Nature of damage These scale insects suck plant sap resulting in defoliation and drying of twigs. They also excrete large quantity of honey dew and as a result of that sooty mould develops on leaves, which checks photosynthetic activity of the plant.

Control Spray Birlane 24 EC (Chlorfenvinphos) 2.1 ml or Sevin 50 WP (carbaryl) 4 gms or Ekalux 25 EC (Quinalphos) 2 ml or Metacid 50 EC (methyl parathion) 1.5 ml or Cythion 50 EC (malathion) 2 ml or Phendal 50 EC (phenthoate) 2 ml or fish oil insecticidal soap 40 gms per litre of water. Second application should be given 7-10 days after first application. Single application of Nuvacron (monocrotophos) 2.5 ml per litre of water is also highly effective.

(2) Brown Scale (*Saissetia Coffeae* (Walker))

Like soft green scale this pest also appears in serious forms in south India. The adult female is red brown to dark brown in colour with smooth and shining surface more or less hemispherical in profile, short oval in contour, measuring 2-3 mm in length and 1.5-2.0 mm in breadth.

Nature of damage Similar to soft green scale

Control Spray Sevin 50 WP (carbaryl) @ 4 gms in one litre of water. Second application should be given 10 days after the first.

(3) Citrus mealybug (*Planococcus citri* (Risso))

This is a serious pest of citrus in many parts of the country. Adult female is slightly elongate, ovate, flattened, light brown with spines projecting from the body margin and posterior end of the abdomen, measuring 3 to 4 mm in length. Their bodies are covered with dense white mealy waxy secretion except at the articulation of the segments.

Nature of damage After hatching, the tiny brownish yellow nymphs start migrating and settling over the suitable plant parts. The mealy bugs prefer to feed on the stalks of fruits resulting in their drop.

Control The chemicals recommended for the control of soft green scale temporarily suppress the population of this pest. However, the pest can be brought under control by releasing predatory beetle *Cryptoleumus montrouzieri* which feeds on all the stages.

(4) Citrus Blackfly *Alerocanthus woglumi* Ashby)

This is a serious pest in Maharashtra. The adults of citrus blackfly are dark orange in colour. The wings are smoke grey with four whitish spots on the forewings. A faint white band can be seen across the middle of the dorsum when the insect is at rest.

Nature of damage Both adults and nymphs suck sap from the lower surface of leaves, which turn pale and look sickly. This pest also excretes honey dew on which sooty mould develops.

Control The measures recommended for the control of scale insects help in controlling this pest, specially the use of Nuvacron.

(5) Aphids *Toxoptera auranti* (B.de f), *T. Citricidus* Kircaldehy, *Aphis citricola* v der Goot)

Aphids or plant lice are green or brown in colour. They live in colonies.

Nature of damage · Aphids attack tender leaves, shoots and flower buds. In case of severe infestation development of affected parts is arrested. The honey dew excreted favours the development of sooty mould on foliage. These aphids transmit 'tristeza' virus which is responsible for citrus decline.

Control Spray Metasystox 25 EC (oxydemeton methys) @ 0.8 ml or Nuvacion 40 EC (monocrotophos) @ 1.0 ml per litre of water during flushing period.

(6) Citrus psylla (*Diaphorina citri* Kuwayama)

This is a serious pest of citrus in North India. The adults are brownish, small in size (about 2.5 mm long) very active and jump on a slight disturbance.

Nature of damage Both adults and nymphs suck sap from the tender leaves, flowers and shoots, resulting in leaf curling, flower drop and death of the shoots. Black fungus develops on the honey dew excreted by the insect. Citrus psylla is more important as a vector of 'greening' disease, which is considered as a major factor of citrus decline in the country.

(7) Citrus leaf-miner (*Phyllocnistis citrella* Staint)

It is another major pest in the citrus growing areas of the country. The adult is a tiny silvery white moth with yellowish markings and a black spot near the tip of each fore wing. 'The hind wings are white and both the pairs are fringed with hairs.'

Nature of damage It is a serious pest of nurseries, young plants and tender flushes of the grown up plants. The larvae usually mine the underside of the leaves making serpentine mines, which are silver coloured due to entrapped air. In severe cases tender twigs may also be attacked. Due to extensive mining by the larvae the leaves get badly distorted, irregularly curled up and in some cases of twig attack, die back has been observed.

Control Weekly spraying of Nuvacron 40EC (monocrotophos) @ 1 ml per litre of water during flushing periods suppresses the population of this pest.

(8) Leaf eating caterpillar (*Papilio demoleus* Linn)

This is a widely distributed and serious pest of citrus. The adults are large, beautiful butterflies. The black front wings are ornamented with numerous yellow spots and towards the inner margin of the hind wings, a brick red oval patch is present.

Nature of damage The caterpillars of this butterfly are very serious pests of nurseries, young plants and young flushes of

mature trees. Sometimes the entire plant is defoliated by the caterpillars. Such outbreaks have been recorded in Maharashtra.

Control. In nurseries and small areas hand pick and destroy the caterpillars. In orchards and large nurseries spray Metacid 50 EC (Methyl parathion) @ 1 ml per litre of water to kill the caterpillars.

(9) Orange shoot borer (*Oberea lateapicalis* Pic)

It is a serious pest of citrus in the mandarin growing areas of south India. The adult is a slender brown insect measuring about 2 cm in length. About 3/4 of the front wings are black in colour.

Nature of damage: The adult female girdles the young flush as a result of which the top of such flush wilts, droops and finally dries. The larva bores downwards into the young shoot and produces frass while feeding.

Control. If the withered shoots are detected early and pruned about 4 cm below the dried portion, further damage by this pest can be prevented. Spraying with insecticides like Metacid 50 EC (methyl parathion) @ 1 ml or Nuvacron 40 EC (monocrotophos) @ 1.25 ml or Sevin 50 WP (carbaryl) @ 4 gms per litre of water at 10-15 days interval during ovipositional period (middle of April to June) can effectively check the pest multiplication.

(10) Orange stem borer (*Chelidonium argentatum* (Dalm)) Serious pest in old and neglected orchards in Malnad Area. The adult is a shining steel blue beetle measuring about 3 cm in length.

Nature of damage. The grubs after hatching bore into the pith and first move towards the end of the branch. After about 2-6 weeks they reverse the direction, enter the thicker branches below and eventually make their way into the trunk where they continue feeding for rest of the life. While feeding, the grubs eject frass from the holes.

Control. Organise a campaign from the end of July to September to prune all the branches containing grubs before they enter into the trunk. If the grub enters the trunk, injection of 15 to 20 ml of petrol or the same amount of solution of Metacid 50 EC (methyl parathion) @ 2 ml per litre of water and plugging of all the holes with wet clay can help in killing it.

(11) Fruit sucking moths (*Othreis materna* L.-*O. fullo-nica* L.) and *Calpe emarginata* Fb)

These pests are serious in Andhra Pradesh and appear in sporadic form in other citrus growing areas. The adults of *O.*

fulvigena are fairly big sized with orange coloured hind wings. *O. materna* moth has greenish forewings and orange coloured hind wings with black spots. The moths of *A. janata* are pale reddish brown, hindwings black with a medial white band and three large white spots on outer margin. The moths of *C. emerginata* have purple brown forewings and pale white hind wings.

Nature of damage The moths are attracted to odours emanating from ripe or rotten fruits and thus the attack takes place at ripening, resulting in fruit fall. They puncture the rind with their proboscis and suck the fruit juice. This puncturing also predisposes the fruits to bacterial and fungal attack resulting in fruit rot.

Control . For the control of fruit moths, the following measures can be adopted

- (a) The moths can be prevented from approaching the fruits either by smokes or by spraying crude oil emulsion and fish oil soap mixtures. Bagging the fruits with 300 gauge alkathene or polythene bags (punctures on the bottom) is also quite effective.
 - (b) Collecting adult moths by light traps, or by keeping attractant traps of cut pieces of fruits near tree basin and killing them is also advised.
 - (c) Baiting with cythion 50 EC (malathion) 2 ml + 10 gms crude sugar per litre of water along with some vinegar or fruit juice.
 - (d) Destruction or eradication of alternate hosts.
- (12) Fruit fly (*Dacus dorsalis* Hendel) : (See under mango)

(13) Red spider mite (*Tetranychus hijiensis* Hirst) .

This mite is a serious pest of citrus. The mite feeds on the under surface of the leaves. It produces profuse webbing.

Nature of damage The feeding in webbs on the underside of the leaves causes specks which are visible even from the upper side. In severe cases leaves curl and even drop.

Control Spray Nuvacrom 40 SC (monocrotophos) @ 0.75 ml or Kilthane 18 EC (dicofol) @ ml per litre of water.

(14) Oriental red mite (*Eutetranychus orientalis* Klein) .

This mite is also a serious pest. It feeds on the upper leaf surface.

Nature of damage . Attacked leaves look dusty. Mite attack causes yellowing of leaves. In cases of severe attack, leaf shedding is common.

Control . Same as for red spider mite

(iii) **Pests of Banana**

(1) Rhizome weevil (*Cosmopolites sordidus* Germ)

This is a major pest of banana. The adult weevil is stout, reddish brown insect.

Nature of damage . The grub after hatching feeds on leaf sheath and tunnels into the sucker. Consequently, the central shoot is killed. The plants show premature withering, the leaves become scarce, the fruits become undersized. In case of severe infestation the plants are killed.

Control . Plant healthy suckers after dipping in Aldrex 30 EC (aldrin) @ 3 ml per litre of water. Apply 60 gm of dieldrin 5% dust or 100 gm BHC 10% dust or incorporate 10 gm of Furadan 3G (carbofuran) or 5 gm of Thimet 10 G (phorate) per pit at the time of planting.

(2) Pseudostem borer (*Odoiporus longicollis* Oliv)

This is a serious pest of banana in north-eastern region, Bihar, Delhi and Uttar Pradesh. The adult is a robust, reddish brown or black weevil and measures 1.3-2 cm in length.

Nature of damage . The grub makes longitudinal tunnels in pseudostem. Small holes with characteristic brownish boundary are visible on the surface of the affected plants sometimes even upto a height of 2 metres. In cases of severe infestation, pseudostem becomes pale and plants get stunted. The plant dies when the heart of the stem is damaged. The attack by this pest leads to secondary infestation by pathogens which results in decay.

Control . Spray the base of the plant with BHC 50 WP @ 3 gms or Metacid 50 EC @ 1 ml per litre of water. To treat one acre or plantation 250-300 litres of spray fluid is required.

(3) Banana aphid (*Pentalonia nigronervosa* (Cox)) :

It is notorious as the vector of the virus causing the bunch-top disease of banana. The aphid is brownish in colour and has black-veined wings.

Nature of damage . They live in colonies within the leaf axils, on tender leaves and at base of the culm. They reduce the vitality of the plant by continuous desapping and transmit deadly bunchy top virus.

Control . Spray Metasystox 25 EC (oxydemeton methyl) @ 2 ml or Nuvacron 40 EC (monocrotophos) @ 1 ml per litre of water.

(iv) Pests of Apple

(1) The woolly apple aphid (*Eriosoma lanigerum* (Hausmn))

This is a serious pest of apple throughout the apple growing areas. The aphid is covered with white waxy threads and looks like white cottony patch. It is reddish or purplish in colour and measures about 2 mm in length.

Nature of damage Aphids feed on plant sap and the vigour and fruiting capacity of the plant is adversely affected. Feeding on roots results in big knots or gall-like swellings.

Control : Plant nursery stock free from woolly aphid. For control of aphid on aerial parts spray rosin soap (25 gms in one litre of water). For root infesting phase (from) apply Metasystox 25 EC (oxydemeton methyl) @ 2 ml or Nuvacron 40 EC (monocrotophos) @ 1.25 ml per litre of water during October-November when trees have no leaves and before the aerial forms migrate to root zone. The parasite, *Aphelinus mali* is very effective in most of the places. The ladybird, *Coccinella septempunctata* and other predators also play important role in the suppression of this pest. (2) San Jose Scale (*Quadraspidiotus perniciosus* Comstock).

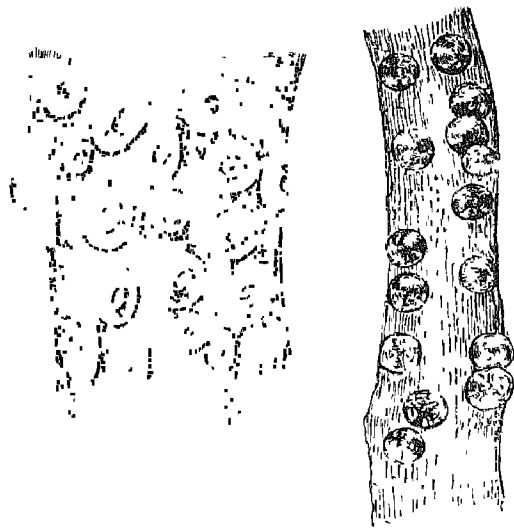
A serious pest of apple, pear, peach and most other temperate fruit trees. This scale insect is prevalent in the hill orchards of the Himalayan tracts. The scale insect is covered with a hard shell. The appearance is ashy grey.

Nature of damage The scale infest leaves, twigs, fruits and stems. The attacked fruits show pink coloured areas around the scale which greatly reduce their market value. Feeding activity of the scales on the plants causes loss of vigour, deterioration in the quality of the fruits and in case of severe infestation plants may die.

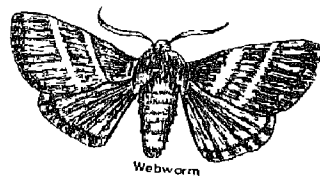
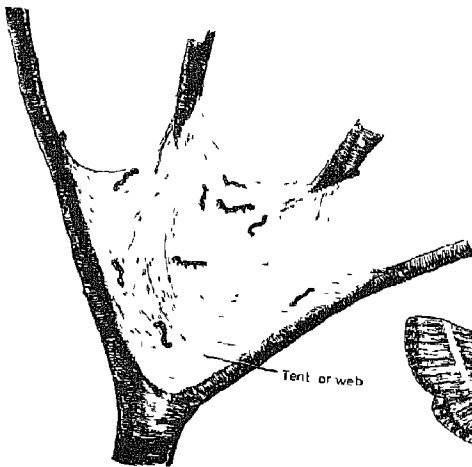
Control Spray during winter (November-December) with diesel oil emulsion (diesel oil 4.5 litres, ordinary soap one kilogram and water 54 to 72 litres) at 8-12 litres per tree. Currently miscible oil is used in place of diesel oil. The exotic parasite, *Prospaltella perniciosi* Tower is quite effective biological control agent. It has established in many parts and doing good job in the suppression of this pest.

(3) Tent caterpillar (*Malacosoma indica* Wlk) .

It is a serious pest of apple and other temperate fruits especially in the U P. and Himachal Pradesh.



SAN JOSE SCALE



TENT CATERPILLER

Nature of damage . The caterpillars feed on foliage and in severe cases only the midrib and the hard veins are left. Caterpillars make nests or silken tents at crotches of small twigs. In the absence of leaves, caterpillars feed on bark.

Control Collect and destroy the egg masses and congregated larvae. Application of grease band to prevent the larvae climbing up the stems and Thiodan 35 EC (endosulfan) @ 2 ml per litre of water on leaves and stems should be followed.

(4) Indian Gypsy moth (*Lymantria obfuscata* Wlk) .

It is a pest of apple, other temperate fruits and forest trees in Himachal Pradesh and Uttar Pradesh.

Nature of damage The caterpillars feed at night and defoliate the trees. About 20-25 per cent of trees in an orchard are defoliated and such trees do not bear any fruit.

Control The egg masses can easily be identified owing to yellowish brown hairs on them. Immediately destroy such egg masses. The debris around the trees should be removed so that the caterpillars do not hide inside them. Spray Thiodan 35 EC (endosulfan) @ 2 ml. per litre of water during March-April if required.

(v) Pests of Grapevine

(1) Flea beetle (*Scelodonta strigicollis* Mots.)

It is a serious pest of grapes and causes considerable loss.

Nature of damage The beetle feeds on emerging buds and young leaves by cutting holes. It also attacks tendrils and scrapes the young berries. Grubs feed on roots.

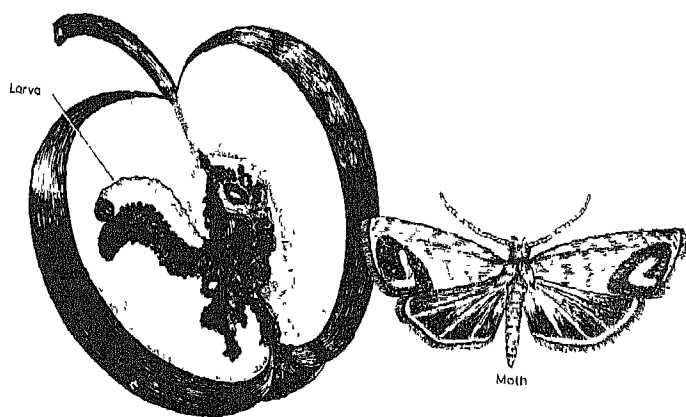
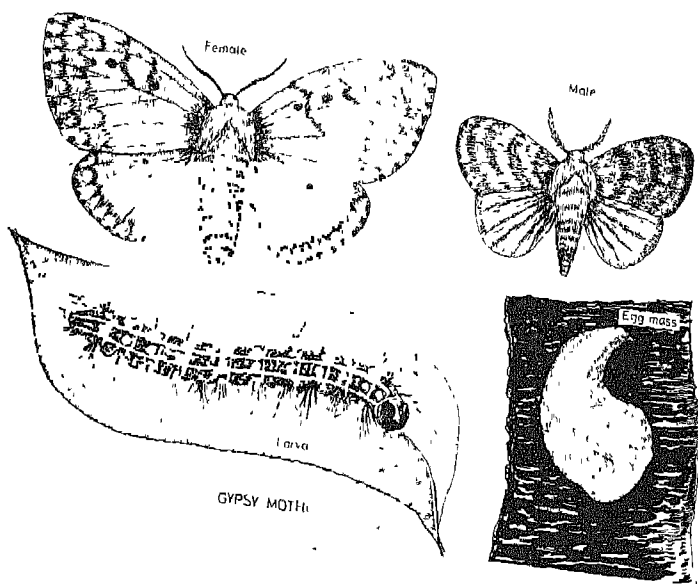
Control Remove the loose bark at the time of pruning which prevents beetles from egg laying. Spray Metacid 50 EC (methyl parathion) @ 1 ml or Ekalux 25 EC (quinalphos) @ 2 ml per litre of water.

(2) Thrips (*Rhipiphorothrips cruentatus* Hood)

Very common pest of grapes throughout the country.

Nature of damage Thrips feed on the lower surface of leaves by rasping and sucking the oozing sap. Infested patches are white which later curl up, wither and drop off prematurely. Scraping of young berries results in formation of corky crust or scab.

Control Spray Nuvacron 40 EC (monocrotophos) @ 1.25 ml or Rogar 30 EC (dimethoate) @ 1.7 ml per litre of water.



(3) Mealybug (*Pseudococcus carymbatus* Green) .

These are small soft bodied insects and are polyphagous in their feeding habit. Mealybugs are serious pests of grapes in Andhra Pradesh and Karnataka.

Nature of damage Both, adult females and nymphs suck sap from leaves, shoots and berries thereby weakening the vigour of the vines. The affected bunches lose their market value. **Excretion** of honeydew by these mealybugs attracts the black sooty mould which hinders the photosynthetic activity of the plant.

Control : Spray Nuvan 100 (dichlorvas) @ 1.5 ml plus fish oil rosin soap 25 gm per litre of water. Encourage the biological control method by introduction of predators and parasites.

(4) Spider mites (*Paratetranychus punicae*) :

It sometimes causes serious damage.

Nature of damage The adults and nymphs suck sap from the leaves. Badly affected leaves show a particular bronzy appearance and ultimately wither and dry.

Control . Spray Kelthane 18 EC (dicofol) @ 2.2 ml or Nuvacron 40 SC (monocrotophos) @ 1.25 ml per litre of water.

(vi) **Pests of Guava**

(1) Fruitfly (*Dacus dorsalis* Hendel)

Dark greenish punctures on the surface of the fruit indicate the infestation of this pest. This is serious during rainy season in Uttar Pradesh. (Refer under mango)

(2) Coccid (*Pulvinaria psidii* Maskell) .

These are green dull oval insects. The females on maturity become white.

Nature of damage Both nymphs and females suck sap from the succulent parts of the plant and excrete honeydew. Black sooty mould develops on the honeydew which interferes with the photosynthetic activity of the plant and reduces the market value of the fruits.

Control . (Refer under citrus mealybug)

(3) **Mealybug** (Refer under citrus mealybug)

(vii) **Pests of Litchi**

(1) Mite (*Aceria litchi* Kiefer)

It is a serious pest in the litchi growing areas of the country.

Nature of damage · The pest becomes serious during April-May and again in September-October. It lacerates the tissues and desaps the leaves and young fruits resulting in brownish velvety growth giving leathery appearance on the underside of leaves. The leaves become curly and growth of the plant is retarded, which affects the yield.

Control Prune the affected portions and spray Kelthane 18 EC (dicofol) @ 2.2 ml or Rogor 30 EC (dimethoate) @ 2 ml per litre of water

(viii) Insect pests of Ber

(1) Fruitfly (*Carpomia vesuvaina* Costa).

It is a common pest of ber throughout the country

Nature of damage : Active during the winter months. Maggots feed and grow within the fruits. Affected fruits become unfit for consumption.

Control Spray Sevin 50 WP (carbaryl) @ 4 gms or Cythion 50 EC (malathion) @ 2 ml per litre of water at fortnightly interval during fruiting period.

(ix) Pests of Pineapple

(1) Mealybug (*Pseudococcus brevipes* Ckll.) :

It occurs throughout the pineapple growing areas of the country. They are small reddish insects having a white waxy covering with tassels on them.

Nature of damage · Mealybug occurs in colonies on leaves and fruits. Both nymphs and females suck sap and devitalize the plants. The insect is suspected to transmit a virus disease which causes wilting.

Control · Use healthy suckers for planting or dip the suckers in Metacid 50 EC (methyl parathion) 2 ml or Basudin 20 EC (diazinon) 50 ml in one litre of water. Apply Thimet 10 G (Phorate) @ 17.5 kg per hectare 100 day after planting.

(x) Pests of Pomegranate

(1) Anar butterfly (*Virachola isocrates* F.)

It is a common pest causing severe loss to fruits. The adult is fairly large brownish butterfly.

Nature of damage. The larva bores into the fruit and feeds on the pulp and seed. The entrance hole on the fruit is slightly difficult to notice. Presence of frass on surface indicates the presence of larvae inside the fruits.

Control · Spray young fruits with Metacid 50 EC (methyl parathion) @ 1 ml or Sevin 50 EC (carbergyl) @ 4 gm per litre of water at fortnightly interval.

(xi) **Pests of custard apple**

(1) Mealybugs (*Ferrisiana virgata* Cockerell, *Pseudococcus lilacinus* Cockerell and *P. pacificus*)

·Mealybugs are common pests of custard apple throughout the country. These are small soft bodied insects with mealy wax coating.

Nature of damage Both nymphs and adult females suck the sap from leaves, shoots, buds and fruits. In case of severe infestation, the affected fruits become deformed and lose their market value. Besides, they exude copious amount of honeydew on which black sooty mould develops thereby interfering with photosynthetic activity of the trees.

Control . Spraying should be avoided and biological control methods should be encouraged as detailed somewhere else in the Manual.

(xii) **Pests of papaya**

Red spider mites and thrips have been reported infesting papaya leaves. Sometimes aphids also attack papaya and transmit mosaic disease. The control measures suggested for these pests on other crops can be safely adopted for the control of these above mentioned pests.

1.3 **Precautions**

- Use the recommended concentration of insecticide or other measures recommended.
- Prepare the desired concentration of insecticides/acaricides just before use, do not store the prepared material. Do not mix insecticides with bare hands.
- Avoid spraying fruit trees when they are in bloom to protect the honey bees and other pollinators visiting flowers.
- Stop spraying trees at least 15 days before harvest.
- Spray only infested trees at right time and avoid unnecessary sprays.
- Wash hands thoroughly with soap and water after spraying/dusting.
- Destroy empty insecticide containers.
- Store the insecticides in a safe place beyond the reach of children and pets.

Consult physician and take the patient to the nearest hospital immediately if symptoms of illness developed during or shortly after spraying

1.4 Materials required

- (i) Power sprayer, Foot sprayer, Knapsack sprayer, gator sprayer, duster
- (ii) Insecticides listed in relevant information.
- (iii) Container like drum or buckets for water
- (iv) Measuring cylinders for measuring insecticides.
- (v) Natural enemies (Predators, parasites etc) of fruit pests.

1.5 Procedure

- Identify the trees or orchards to be sprayed or suitable for biological control. If more than 50 per cent of the trees are infested operations can be taken in the entire orchard.
- Identify the pest and mark the trees requiring spray before starting any pest management programme.
- In the orchard select at least 4 trees at random and on each tree 10 twigs (15 cm length) at random representing all sides of the tree and tag them
- Mix the desired quantity of concentrated insecticide in deep bottom vessel with the help of long-handled mixers in the desired concentration. The release of predator or parasite should be done in the morning
- While spraying or dusting cover the trees uniformly.

1.6 Observations

The pupil should take and record the following observations :

- Count the number of insects on these tagged twig a day before taking up spray, or any other control measure
- After application counts should be taken after 3, 7, 10 and 14 days
- Record yield data in treated and untreated trees.
- Observe the trees for any phytotoxic symptoms

1.7 Calculations

The pupil should calculate the quantity of insecticide required.

- Sometimes in the market, insecticides are available with different active ingredients.

To calculate the dilution by parts (insecticide-water ratio) the following formula should be used

$$RD \times PA / PD$$

Where-

RD×Ratio of Dilution

PA×Percentage of Active ingredient in the formulation.

PD×Percentage of Dilution required

- For calculating the effectiveness of control operation taken the following formula should be used

Number of insects before spray—No. of insects after spray
X 100

No. of insects before spray.

This gives the per cent mortality.

1 8 **Expected behavioural outcome**

The pupil acquires the following abilities to

- identify the insect pests,
- estimate the extent of damage,
- organise control measure,
- calculate the effectiveness of control operation

The teachers should evaluate the pupil for the above abilities

1 9 **Questions**

- (i) Name common insect pests of mango, citrus, banana and apple
- (ii) What control measures are suggested against citrus leaf-miner, mango hopper, banana rhizome weevil and wooly apple aphids?
- (iii) If you know the active ingredient of an insecticide, how you will calculate insecticide-water ratio?
- (iv) How you will calculate the effectiveness of control measures organised?

BIOLOGICAL CONTROL OF MEALYBUGS IN CITRUS ORCHARDS

2.1 Instructional objectives

The pupil should be able to :

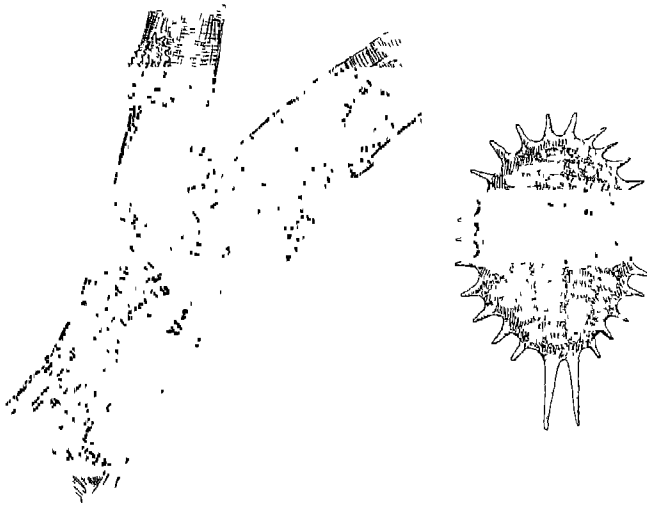
- understand what is meant by biological control,
- know the different stages of the predator;
- learn propagation technique of the mealybug and its predator,
- know procedure for field release

2.2 Relevant information

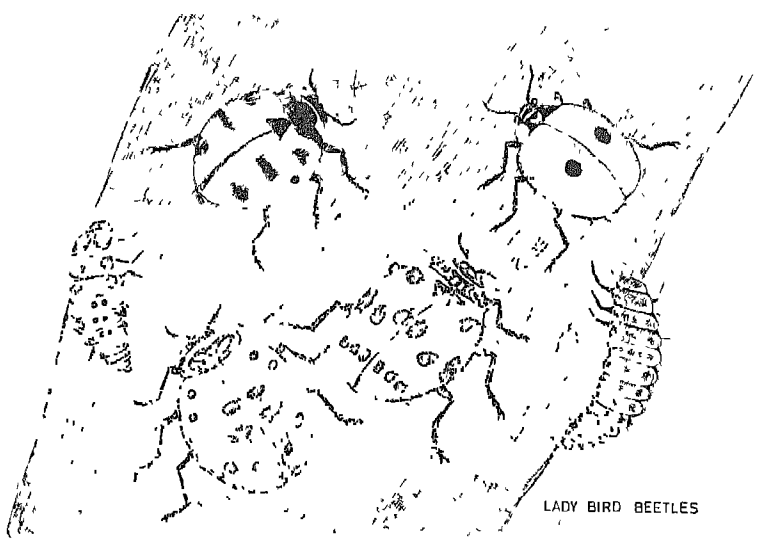
Mealybugs are serious pests of citrus and coffee. They prefer to feed on the stalks of fruits or berries resulting in their drop. In most of the cases, insecticides are recommended for the control of mealybugs. But chemical control does not give the desired results. The other possibility is the use of biological control method (the multiplication of predator or parasite of the phytophagous insect and releasing it in suitable sites). For the biological control of mealybugs (*Planococcus* sp. and *Pseudococcus* sp.) on citrus a simple mass multiplication technique for host mealybug and its effective predator, *Cryptolaemus montrouzieri* Muls. is very useful which has been evolved by IHR, Bangalore.

2.2.1 Multiplication technique for citrus mealybugs

The propagation of citrus mealybug is carried out on ripe pumpkins. The pumpkins are selected with ridges and grooves with a small stalk which makes the handling easy. To prevent rotting, the pumpkins are treated with 0.1 per cent (one g/lit)



MEALY BUG



LADY BIRD BEETLES

Benlate Pure culture of citrus mealybug is maintained in the infestation room and the crawlers emerging are released on the upper side of the pumpkin which is kept on a plastic pumpkin-stand inside the cage. In due course of time the crawlers settle on all sides of the pumpkin and develop into fully mature mealybugs in about 27 days. The mealybug infested pumpkin is exposed to beetles for a period of 24 hours any time after 15 days of the initial infestation of crawlers. The culture of adult beetles is maintained in the breeding cage (about 100 beetles/cage). These beetles are used for a period of about 16 days after which they are released in the field. The mealybug infested pumpkin after exposure to beetles is again kept back in the original cage where the breeding continues. At the bottom of the breeding cages some dried leaves are kept to facilitate pupation of the grubs.

The beetles lay their eggs singly or in groups of 4-12 in the ovisacs of female mealybugs. If the females are not fully developed the eggs are laid anywhere near the mealybugs. The grubs are visible in about a week's time. Initially they feed on the eggs of mealybugs and as they grow in size they start feeding on mealybugs adults and nymphs. When full fed, the grubs of the last (4th) instar pupate in the leaves or any where inside the breeding cage. The pupa is located in the exuvia of the last instar grub.

The first beetle from this breeding cage emerges in 30 days time from the date of exposure to beetles. The beetles continue emerging in fairly large numbers for a period of 10-20 days and are collected daily and kept in breeding cage for mating. Beetles (after mating) are taken regularly for experimental releases in the mealybug infested areas. Each breeding cage yields about 173 beetles.

Field release technique

For this purpose the adult beetles are packed according to requirement in perforated polyethylene bags with the help of rubber bands. The beetles in bags are kept overnight and released the next day. Perforated bread boxes can also be used.

Based on the experiments conducted the following procedure should be followed before the first release of the predator is made.

1. Mark the mealybug infested plants early in the season.
2. Put a band of diazinon 5 per cent granules around the trunk of the plant leaving about 30 cm from the main stem. All other ant control methods should be followed such as destruction of ant-holes, red ant nests and skirting of citrus trees after fruit harvest.

which prevents the ant migration through side branches (*Failure to control ants may prove detrimental to biological control programme*)

3 Once the patrolling (up and down) of ants on the trunk is stopped, the beetles can be released. In bearing mixed planted orchards the number of beetles (per cent) should be released as follows

Coorg mandarin	10
Robusta coffee	5
Arabica coffee	3
San-remon cofee	2

4 Periodic check should be made for the first fortnight and after about twenty days from the release date, dried leaf mulch should be put around the stem or trunk of the plant to facilitate pupation, as the full fed grube usually seek pupation sites near the base of the plant

If the releases are made early in the season and the first generation beetles develop from the released beetles, the second generation definitely brings the mealybug population to a negligible level. One to three releases are required annually in areas with fairly high mealybug populations

2.3 Precautions

- Keep always sufficient number of pumpkins infested with mealybugs otherwise there is a possibility of losing the culture of predatory beetle due to lack of food
- Do not allow the ants inside the insectary (rearing rooms for host and predator)
- Beetles kept for field release should not be starved for more than 18 hours
- For long distance shipment even the beetles should be provided with food, and the shipment should invariably be done in hard plastic containers with sufficient aeration

2.4 Material required

- i. Two rearing rooms (insectary) The rooms should preferably be ant and rat proof
- ii. Rearing cages 30 cm x 30 cm x 60 cm with a slanting glass top and other sides covered with muslin cloth or fine wire mesh
- iii. Ripe pumpkin for multiplication of mealybugs
- iv. Fine brushes, glass tubes, plastic boxes and bags.
- v. Culture of citrus mealybug

- vi Culture of predatory beetle *Cryptoaemus montrouxiere*
- vii Benlate or Bavistin for treating pumpkins

2.5 Procedure

- Treat the pumpkins with 0.1 per cent (one gm/1) Benlate or Bavistin.
- Infest the pumpkins with mealybug crawlers
- Expose the mealybug infested pumpkin (after 15 days of initial infestation) to 100 beetles for 24 hours.
- Remove and keep the beetle exposed mealybug infested pumpkin in a separate cage
- Go on exposing the mealybug infested pumpkin for 10 days (in the same cage containing 100 beetles)
- (First beetle from exposed pumpkin will emerge after about 27 days)
- Go on collecting the beetles for another 10-20 days
- Keep the daily collection of beetle in a cage for three days so as to allow them to mate (Beetles are now ready for release in the field).
- In the field apply a band of 5% diazinon (or any other dust) around the trunk leaving about 11 allround
- After 24 hours of this, release 10 beetles on bearing citrus tree.

2.6 Observations

The pupil should take and record the following observations :

- a. Take the initial count of mealybugs on trees selected for the release of beetles by randomly tagging 10 (15 cm long) branches
- b. After release of beetles take populations counts at weekly interval.
- c. Observe the immature stages of the beetle (grubs pupae, etc)
- d. After about 20 days of the release of beetles search grubs/pupae in dried leaves near the base of trunk.

2.7 Calculations

Calculate the per cent suppression of the mealybug by the method of calculation given elsewhere (under fruit pests) in this manual

2.8 Expected behavioural outcome

The pupil acquires the following abilities to

- understand biological control,
- practise mass multiplication technique for mealybugs on alternate host

- practise mass multiplication technique for **predatory beetle**;
- master field evaluation technique for **biological control agents**;
- arrange multiplication of predator for sale.

The teacher should evaluate the pupil for the above abilities.

2.9 Questions

- i What is biological control?
- ii What is the procedure for multiplication of **citrus mealybug** on artificial host (pumpkin)?
- iii What is the procedure for field release of **predatory beetle**, *Cryptolaemus montrouzieri*?
- iv How you will evaluate the effectiveness of the **predator**?
- v If you have to start a predator multiplication unit what type of space and equipment you would like to acquire?

MANAGEMENT OF INSECT, MITE AND NEMATODE PESTS OF VEGETABLE CROPS

3.1 Instructional objectives

The pupil should be able to

- identify the common insect and mite pests of vegetable crops,
- understand the nature and extent of damage,
- organise control measures,
- understand the use of application equipment for all the pests

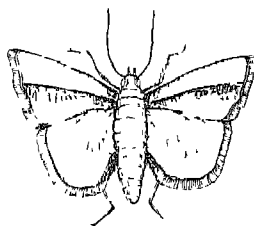
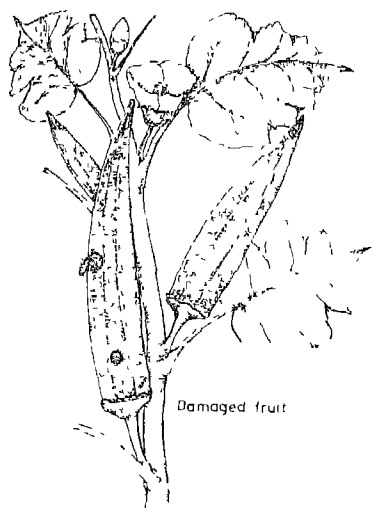
3.2 Relevant information

(i) Pests of Okra (Bhindi)

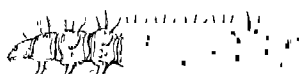
(1) Shoot and fruit borer (*Earias* spp)

The moth of *E. Vittells* Fabr has yellowish head and thorax. Its forewings are pale white with a broad, wedge-shaped greenish band in the middle. It measures about 9.5 mm long and 19 to 24 mm across the wings. *E. insulana* Boisd has completely green forewings and wing expanse is about 25 mm. The caterpillars of both the species are brownish white with a number of black brown spots on the body and have a dark head and a prothoracic shield. Both the species cause serious damage to *bhindi* throughout the plains of India. They also attack cotton, ambadi, *Hibiscus* flower, and other malvaceous plants.

Nature of damage. Caterpillars bore into tender shoots, flower buds and fruits. The damaged shoots dry up while flowers, buds and developing fruits drop down prematurely. Affected fruits remaining on the plant become unfit for human consumption.



Moth



Caterpillar

FRUIT AND SHOOT BORER (*Earias* sp)



Moth



Pupa



Caterpillar



Eggs

SHOOT AND FRUIT BORER (*Leucinodes orbonalis* Guen)

Control Remove and destroy the infested shoots, fruits and shed material. Spray Sevin 50 WP (carbaryl) at 2 gm per litre of water at weekly intervals during fruiting stage. During vegetative stage spray Nuvacron 40 SC (monocrotophos) at 1.25 ml per litre of water.

(2) Jassids (*Amrasca biguttula biguttula* Ishida)

The adult is wedge-shaped, about 2 mm long and pale green in colour. Its forewings have a black spot on the posterior parts. The nymphs are wingless, pale green in colour and can be located on the lower surface of the leaves in large numbers. Distributed throughout the country.

Nature of damage Both nymphs and adult suck sap from leaf tissues. The affected leaves curl upwards along the tips and margins and develop necrotic areas which extend to entire leaf surface resulting in drying up of the leaves. The pest also attacks brinjal, potato and cotton.

Control Apply Solvirex 5 G (disulfoton) or Furadan 3 G (carbofuran) at the rate of 10 kg/ha during sowing or spray Nuvacron 40 EC (monocrotophos) as and when the insect appears. Sevin sprayed for the control of boll worms also checks the population of this pest.

(3) Aphids (*Aphis gossypii* Glov.)

The aphids are widely distributed throughout the country. The adults are yellowish to dark green or blackish in colour and are about 1.25 mm in length. The adults are mostly wingless but later in the season at the maturity of the crop, winged adults are also found. Their wings are transparent some times with black lines. The nymphs are green to brown in colour.

Nature of damage Nymphs and adults suck the plant sap and reduce the vigour. When the population of aphids is high the yield is considerably reduced. While feeding aphids excrete honeydew on which black fungus, commonly called sooty mould develops. Coating of the leaves with this fungus interferes with the photosynthetic process of the plant.

Control Spray Rogor 30 EC (dimethoate) or Nuvacron 40 EC (monocrotophos) both at 1 ml per litre of water at the time of appearance of aphid and repeat at fortnightly interval if necessary.

(4) Red spider mites (*Tetranychus* spp.)

The reddish mites live beneath the webs on the leaf surface. It has a very wide distribution.

Nature of damage The mites suck sap from the under surface of the leaf and tender parts and produce characteristic pale speck. With the rise in mite population, specks coalesce giving rise to wider blotches and in case of severe infestation leaves shed in large number

Control Spray kelthane 18 EC (dicofol) at 1.5 ml or Rogor 30 EC (dimethoate) at 1 ml per litre of water

(5) Root knot nematodes (*Meloidogyne incognita*) .

Very common pest of this crop throughout the country

Nature of damage . The infested plants are stunted with galls found scattered on roots. There is a marked reduction in root growth which ultimately affects the yield

Control Pre-plant application of Temik 10 G (aldicarb) Furadan 3 G (carbofuran) at 6 kg/ha helps getting more yield from nematode infested fields. Harvest okra fruits 50 days after sowing, it will be safe for human consumption

(ii) Pests of Brinjal

(i) Shoot and fruit borer (*Leucinodes orbonalis*/Guen)

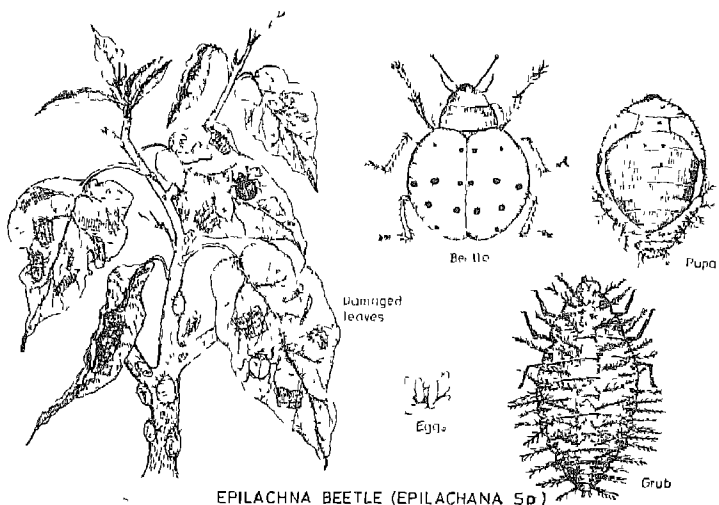
An important pest of brinjal throughout the country. The moths are medium sized. They measure about 10 mm in length with about 20 mm wing span, having whitish wings with large brown patches

Nature of damage . During vegetative stage the caterpillar bores into midrib, petiole and shoot resulting in withering of terminal portion. During fruiting stage, the larvae enter the young fruits through calyx and feed therein rendering them unfit for consumption. The pest is serious in rainy season

Control Periodically remove and destroy affected shoots and fruits with caterpillars. Spray Sevin 50 WP (carbaryl) at 2 gm or Sumicidin 20 EC (fenvalerate) at 0.5 ml per litre of water at fortnightly intervals commencing from the first fruit set. Observe 5 days gap between spraying and harvesting of fruits. During vegetative stage spray Ekalux 25 EC (quinalphos) at 2 ml on Birlane 24 EC (chlorfenvinphos) at 2.1 ml per litre of water

(2) Epilachna beetle (*Epilachna* spp)

These beetles are spherical, pale brown and mottled with black spots. *Epilachna* 12 stigma has 12 spots and *Epilachna* 28-punctata has 28 spots. The grubs are yellowish, fleshy with stout



EPILACHNA BEETLE (EPILACHNA Sp)



FRUIT BORER (Heliothis armigera Hub)

hair on their body. *Epilachna* beetles are important pests of brinjal

Nature of damage Grubs and adults feed on leaves causing skeletonized patches. The attacked leaves sometimes dry up.

Control Collect yellowish egg/masses, and beetles (early morning by shaking plants) and destroy them. Spray Sevin 50 WP (carbaryl) at 3 gms or Cythion 50 EC (malathion) at 2 ml or Difterax 50 EC (trichlorophen) at 2 ml per litre of water.

(3) Root knot nematodes (*Meloidogyne* spp.)

(Refer under okra)

(iii) Pests on tomato

(1) Fruit borer (*Heliothis armigera* Hub.)

The borer, *H. armigera* is a serious pest of tomato throughout the country. The moths are stout, pale brown or light yellowish brown, with a wing expanse of about 40 mm. The forewings are pale brown with some black dots and the hindwings are lighter in colour with smoky dark margins. The caterpillars are greenish or different shades of brown and measure 40 to 50 mm in length when fullgrown.

Nature of damage Young larvae feed on tender foliage, later enter the fruits and feed therein. The attacked fruits are rendered unmarketable.

Control Spray Cythion 50 EC (malathion) at 2 ml or Sevin 50 WP (carbaryl) at 3 gms per litre of water at fortnightly interval. After each spray do not harvest fruits upto 4 days. Hand pick and destroy the caterpillars.

(2) Jassids (*Amrasca biguttula biguttula* Ishada)

(Refer under okra)

(iv) Pests of cabbage and cauliflower

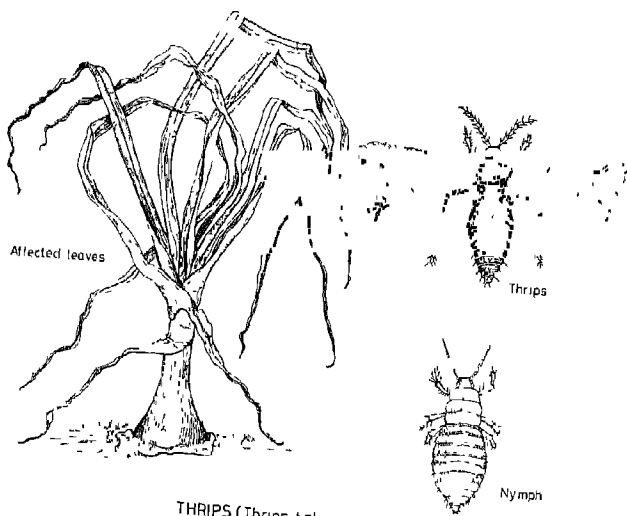
(1) Aphids

Aphids (*Brevicoryne brassicae* Linn., *Lipaphis erysimi* (Kalt.) and *Myzus persicae* Sulz.) attack these crops. Yellowish green and soft aphids are about 2.5 to 3 mm long. Generally apterous forms occur, but winged forms are produced at the maturity of the crop, when they migrate. Wings are transparent and veins are distinct.

Nature of damage Both nymphs and adults suck sap and reduce the vigour of the plant. In cabbage the aphids get into inner leaves of the head and in cauliflower all the inner spaces in the



CABBAGE BUTTERFLY



THRIPS (*Thrips tabaci* Lind.)

head are filled by aphids thus making the vegetable unmarketable. In flowering plants the growing points of the main shoots and their branches are killed and owing to very heavy infestation the growth of the cabbage plants is greatly arrested. These aphids also attack other cruciferous crops viz., knolkhol and turnip and flowering plants of radish and mustard.

Control Spray Rogor 30 EC (dimethoate) or Metasystox 25 EC (oxydemeton methyl) at 1 ml per litre of water. Observe one week interval for Rogor and two weeks for Nuvacron and Metasystox between spraying and harvest.

(2) Diamond back moth (*Plutella xylostella* Linn)

The diamond back moth is a serious pest of cabbage which is widely distributed in the country. The small greyish moths are about 8 mm long. The folded wings flaring outward and upward toward their tips and in the male, forming a row of the diamond-shaped yellow spots where they meet down the middle of the back. The posterior wings have a fringe of long hairs. Caterpillars are pale yellowish green in colour with fine scattered erect black hairs over the body.

Nature of damage Very small greenish caterpillars feed on the upper surface of the leaves, making many small holes, giving a shot-hole appearance all over the leaves.

Control Spray Cythion 50 EC (malathion) at 2 ml or Ekalux 25 EC (quinalphos) at 2 ml or Tamaron 50 EC (methamidophos) at 1 ml per litre of water. Observe four days gap in case of Cythion and 2 weeks gap for Ekalux and Tamaron between spraying and harvesting. Remove the outer leaves before consuming the heads.

(3) Leaf webber (*Crocidolomia binotalia* Zill.)

The adults are small smooth, having pale brown mottled wings with characteristic wavy bands. The caterpillars are green with stripes on the body.

Nature of damage The caterpillars of the cabbage leaf webber spin a web on the lower surface of the leaves and feed under its cover on the leaf tissue. Occasionally it bores into the promordium.

Control (Refer under diamond back moth).

(4) Stem borer (*Helicella undalis* Fabr.)

The adult is a pale yellowish brown moth with wavy grey markings on the wings. Mature larva is about 16 mm in length.

with pale whitish brown colour and three or four longitudinal strips.

Nature of damage The newly hatched caterpillars mine into the leaves and later prepare covered passage made of silk and excrement and ultimately bore into the stem causing the death of the plants

Control Hand pick and destroy the caterpillars. The measures taken for the control of diamond back moth help in checking the population of this pest

(v) Pests of beans, peas and cowpea

(1) Stem fly (*Melanagromyza phaseoli* Tryon)

The adult is metallic black. The eyes are light brown, wings are hyaline and there is a distinct notch in the costal region. The average measurement of the fly is 2.07 x 4.97 mm including the wing expanse. The female is slightly bigger than the male

Nature of damage Maggots feed on the outer layers of the stem of the young plants at the collar region resulting in the death of the plants. The adult females also damage the leaves by puncturing them. The punctured leaves droop down and dry up. In acute cases of infestation the larval gallery in the basal portion of the stem turns rusty and is filled with frass. Early sown peas are more susceptible than late sown crop. The maggot also attacks cowpea and creeper beans

Control: Spray Rogor 30 EC (dimethoate) at 1 ml per litre of water twice at weekly intervals from the time of complete germination.

(2) Pea aphid (*Acyrtosiphon pisum* Harris)

The aphid, *A. pisum* is a common and serious pest of pea. The small pale green insects measure about 4 mm in length. Antennae are long. The terminal shoot, leaves and the branches may be found covered with myriads of winged and wingless aphids.

Nature of damage Aphids suck the sap of the plant and possibly also inject toxins into the plant. When the aphids are abundant, their shed skins give the plants and ground a whitish appearance. When the infestation is severe it may kill the plant or at least reduce the yield drastically besides affecting the quality. If flowers are attacked, fruits do not set.

Control. Spray Rogor 30 EC (dimethoate) at 1 ml per litre of water. Furadan 3 G (carbofuran) at 33 kg/ha can also be applied at the time sowing

- (3) Pod borers (*Adisura atkinsoni* Moore, *Heliothis armigera* Hub etc)

A. atkinsoni moths are straw coloured. Wings are with prominent veins. The caterpillars are green coloured with thin white longitudinal stripes on dorsal side (*H. armigera* has been described elsewhere in this manual)

Nature of damage. The caterpillars initially feed on foliage. They bore into the pods, damage the green seeds and fill the pods with excreta

Control. Spray Sevin 50 WP (carbaryl) at 4 gms or Phendal 50 EC (phenthoate) at 1 ml or Sumicidin 20 EC (fenvalerate) at 0.5 ml per litre of water

(vi) Pests of onion, capsicum and chillies

- (1) Thrips (*Thrips tabaci* Lind and *Scirtothrips dorsalis* Hood)

The adult onion thrips are yellowish in colour with slender body, pointed at both ends. The largest of them is only 1.2 mm long. The male is smaller and lighter in colour than female.

Nature of damage. These minute insects lacerate plant tissues and suck the sap from the leaves forming white blotches in case of onion and curly leaves with stunted plant look in capsicum. In severely infested fields the entire crop gives whitish appearance with drying tips and thin leaves of onion.

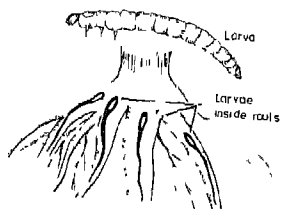
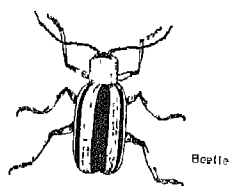
Control. Spray Cythion 50 EC (malathion) at 1.5 ml or Rogor 30 EC (dimethoate) at 1 ml or Nuvacron 40 EC (monocrotophos) at 1 ml per litre of water

(VII) Pests of cucurbits (Gourds, Pumpkin, Melons etc.)

- (1) Red Pumpkin beetle (*Raphidopalpa foveicollis* Lucas)

The beetle is orange-red coloured, about 7 mm long and about 2.6 mm broad. The body has a very shining dorsal smooth surface and its underside is entirely black and covered with short white soft hair like setae. The grub is small yellowish white with a brownish head and when full-grown measures about 12 mm in length.

Nature of damage. The adult beetles feed voraciously on foliage and are destructive to seedlings often necessitating resow-



STRIPPED CUCUMBER BEETLE

ing The grubs feed on the roots and stems below the ground. Damaged roots and stems rot due to infection by saprophytic fungus.

Control : Grow a few scattered cucurbit plants in January and destroy the attracted beetles by foliar spray of Sevin 50 WP 2 gms per litre of water or Cythion 50 EC (malathion) 2 ml per litre of water and their immature stages by treating the soil with insecticides like Aldrin 5% dust at 24 kg/ha. For protecting the seedlings spray Sevin 50 WP (carbaryl) at 2 gms or Cythion 50 EC (malathion) at 2 ml per litre of water.

(2) Fruit fly (*Dacus cucurbitae* Coq)

The adult is a reddish brown fly with lemon yellow curved vertical markings on the thorax. The female fly is 5 mm long and the male is slightly smaller in length. The abdomen of the female ends into a conical oviposition and the male has a spherical abdomen. The wings are transparent possessing brown bands and grey spots at the apex. Halteres (hind short wings) are distinct. The wings are fully stretched at the resting position and during the act of oviposition. The pest is widely distributed.

Nature of damage . The pest attacks mostly at the early stage of the fruit development. Affected fruits mostly do not develop and those which develop become unfit for consumption as they contain maggots inside. Due to the attack of this pest, fruits are also deformed.

Control : Destroy the damaged fruits along with maggots. Spray Sevin 50 WP (carbaryl) at 4 gms or Cythion 50 EC (malathion) at 2 ml per litre of water two to three times at ten day interval from the time of flowering.

(3) Root-knot nematode (*Meloidogyne* spp.)

This gall forming nematode is distributed throughout India.

Nature of damage . Galls are formed on the roots. Root growth is arrested and the plants become stunted. The fruit yield is reduced considerably.

Control . Pre-Plant application of Furadon 3 G (carbofuran) at 33 kg/ha or Dasanit 5 G (fensulfothion) at 20 kg/ha or Temik 10 G (aldicarb) at 10 kg/ha is necessary in nematode infested fields.

(viii) Pests of Amaranthus

(1) Aphids (*Aphis craccivora* Koch.)

This is one of the commonest aphids found in India. There are tiny insects which live in colonies. The colour of the aphid is dark brown to black. The species is widely distributed and attacks a number of crops.

Nature of damage They are usually noticed on the underside of the leaf but when population is high they are also seen on all tender parts of the plant viz., shoot and fruit buds. Nymphs and adults suck the sap and reduce plant vigour. In case of severe infestation the plants become stunted and the yield is reduced.

Control Spray Cythion 50 EC (malathion) at 1 ml per litre of water.

(2) Caterpillars

Leaf eating caterpillars (*Hymenia recurvalis* Fab.) green semilooper (*Plusia gamma* D) and cutworm (*Spodoptera exigua* Hb.) are found to attack this crop.

Nature of damage The caterpillars feed on leaves sometimes causing extensive defoliation.

Control Spray cythion 50 EC (malathion) at 2 ml or Sevin 50 EC (carbaryl) at 2 gm/litre of water. Observe at least 4 days gap between spraying and harvesting.

(3) Inflorescence thrips (*Euryaplothrips crasus* R & M and *Haplothrips caylonius* Sch.,)

These tiny insects attack the inflorescence.

Nature of damage They lacerate plant tissues and suck the sap from the leaves forming curly leaves with stunted plant look.

Control Spray Cythion 50 EC (malathion) at 2 ml per litre of water.

(4) Amaranthus weevils (*Hypolixus frumcatulus* and *Ptochus ovuluran* Fet.)

Nature of damage The grubs feed on the roots of plants and cause wilting and drying of plants. The adults feed on the leaves from the edges in a characteristic manner. When disturbed the adults fall to the ground and remain motionless.

Control Spray Sevin 50 EC (carbaryl) at 2 gm per litre of water at fortnightly interval for control of adults. For grubs



Egg laying female

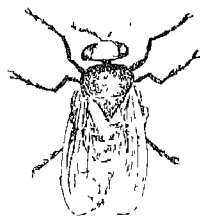


Eggs

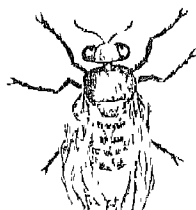
Larvae



Pupae



Male



Beard 1 wing

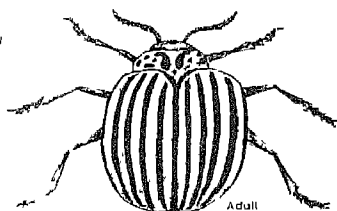


Vestigial wing

FRUIT FLY



Larva



Adult

POTATO BEETLE

incorporate Heptachlor dust or any other available dust at 20 kg per acre.

(ix) Pests of potato

- (1) Aphids (*Myzus persicae* Sulz *Aphis gossypii* *Macrosiphum euphosibia* (Thomas).

These are small insects about 1 mm long dark yellowish green in colour.

Nature of damage Cause damage by sucking the plant sap. In severe cases the leaves become wrinkled The aphids transmit leaf roll virus.

Control Spray Nuvacron 40 EC (monocrotophos) at 1 25 ml per litre of water (refer under cabbage and cauliflower)

- (2) Jassids (*Amrasca biguttula biguttula* Ishida)

(Refer under Bhindi)

- (3) Cutworm (*Agrotis insilon* (Hubn.))

It is a polyphagous pest. Adult moth measures about 25 mm long, had dull brownish forewing with numerous wavy lines and spots; hind wings are bacon coloured The full grown caterpillars are about 40 mm in length, dirty black (dark brown) in colour and have a habit of coiling up at the slightest touch

Nature of damage The caterpillars are active at night They cut the young plants at a height of about 5 cm from ground level and feed on tender leaves and shoots. Some times they cut the entire row of plants When tubers are formed, grown up caterpillars feed on them rendering them unfit for marketing

Control Before sowing apply 2.5 litre Aldrin 30 EC or Heptachlor 20 EC per acre at the time of ploughing or with watercan in about 1000-1500 litres water over the ridges just before earthing up

- (4) Epilachna beetles (*Epilachna* 12-punctata Muls and *Epilachna* 28-punctata Fb)

(Refer under brinjal)

- (5) Potato tuber moth (*Phthorimaea operculella* Zell)

The adult is a small moth greyish brown in colour Wing expanse 14.1 to 15.8 mm and body length of 5.9 mm Full grown caterpillars are about 19.1 mm long, pinkish white or greenish with dark brown head

Nature of damage · The insect initially infests potato crop in the field and then becomes serious on tubers in the storage. The caterpillars in the field mine into the leaves, bore into petioles and terminal shoots. On the tubers they bore, making irregular galleries. The infestation in storage range from 30-70 per cent.

Control Spray Sevin 50 WP (carbaryl) at 4 gm per litre of water at fortnightly interval after the damage is noticed.

3.3 Precautions

- Use the recommended concentration of insecticide or other measures recommended.
- Prepare the desired concentration of insecticide just before actual use, do not store the prepared solution.
- Avoid spraying if the crops are in bloom to protect the honey bees and other pollinators visiting flower.
- Store the insecticides in a safe place beyond the reach of the children, irresponsible persons and pets.
- Destroy empty insecticides containers by burying them deep.
- Use insecticides when required as they are costly input.
- Wash hands thoroughly with soap and water every time the sprayer or the duster is filled with pesticides, before eating, drinking or smoking and at the end of the day's work.
- Consult physician and take the patient to the nearest hospital immediately if symptoms of illness occur during or shortly after spraying or dusting.

3.4 Material required

- Knapsack sprayer, gator rocking sprayer, duster
- Insecticides listed in relevant information.
- Drum or buckets for storing water and mixing insecticides
- Natural enemies (Predators, parasites etc.), of pests
- 10 x and 20 x lenses

3.5 Procedure

- Identify the pest and mark the fields requiring spray before starting any pest management programme.
- In one acre plot at least select four spots randomly and at each spot mark 10 plants and count the number of insects and type of injury caused.
- Mix the desired quantity of concentrated insecticide in deep bottom vessel with the help of long-handled mixers in the

desired concentration.

- Release predator or parasite in the morning
- While spraying or dusting cover the plants uniformly

3.6 Observations

- Count the number of insects on these marked plants a day before taking up spray, or any other control measure
- Post-treatment counts should be taken after 1, 3, 7, 10 and 14 days
- Observe the plants for any phytotoxic symptoms.

3.7 Calculations

The pupil should calculate the quantity of insecticide required for dilution

- Sometimes in the market insecticides are available with different active ingredients, to calculate the dilution by parts (insecticide-water ratio) the following formula should be used

$$RL = PA / PD$$

Where RD = Ratio of dilution

PA = Percentage of active ingredient in the formulation

PD = Percentage of dilution required

- For calculating the effectiveness of control operation taken the following formula should be used,

$$\frac{\text{Number of insects before spray} - \text{No. of insects after spray}}{\text{No. of insects before spray}} \times 100$$

No. of insects before spray

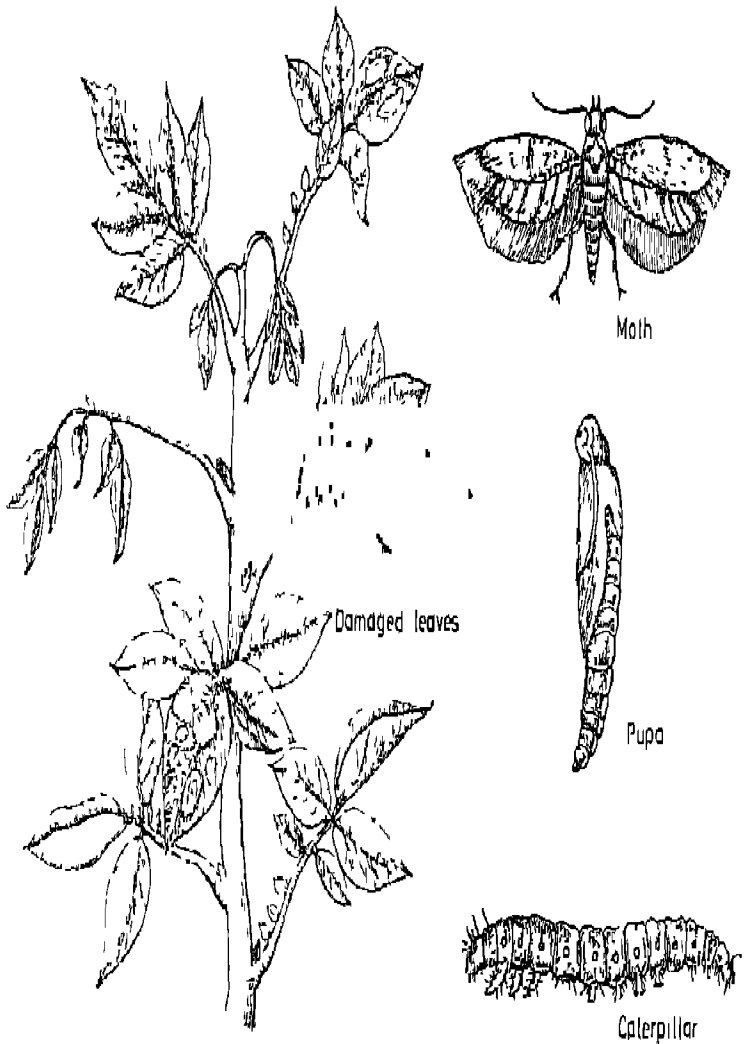
This gives the percent mortality.

3.8 Expected behavioural outcome

The pupil acquires the following abilities to

- identify the pests ,
- estimate the extent of damage ,
- organise control measure ,
- calculate the effectiveness of control operation.

The teacher should evaluate the pupil for the above abilities



POTATO TUBER MOTH (*Phthorimae operculella* Zell)

3.9 Questions

- (i) Name common insect pests of cabbage, brinjal and potato
- (ii) What control measures are suggested against okra shoot and fruit borers, *Epilachna* beetle, cabbage aphids, onion thrips, red pumpkin beetle, potato tuber moth and root knot nematodes?
- (iii) If you know the active ingredient of insecticide how you will calculate insecticide water ratio?
- (iv) How you will calculate the effectiveness of control measure organised?

MANAGEMENT OF INSECT, MITE AND NEMATODE PESTS OF ORNAMENTAL PLANTS

4.1 Instructional objective

The pupil should be able to

- identify the common insect pests of ornamental plants;
- understand the nature and extent of damage ,
- organise control measures ,
- understand the use of application equipment for all the pests.

4.2 Relevant information

(i) Pests of roses

(1) White ants or termites (*Odontotermes obesus* Ramb)

Pale white, abdomen broadly joined to thorax. These social insects live in colonies

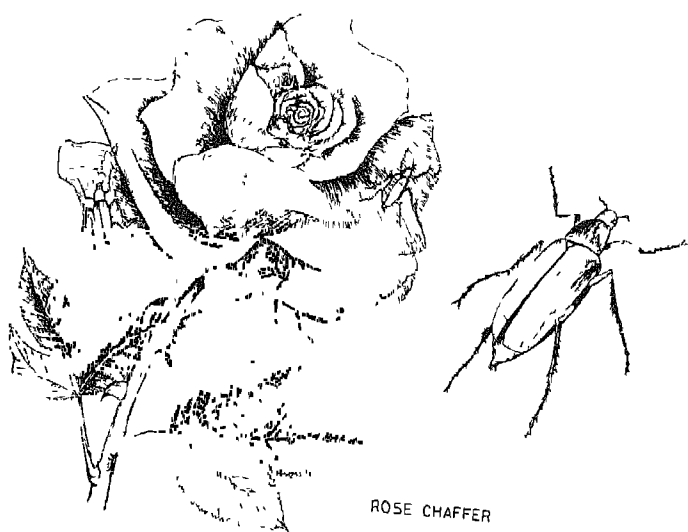
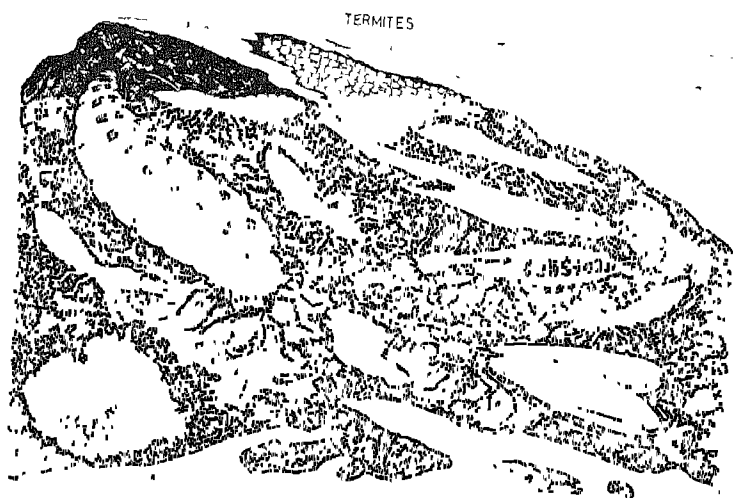
Nature of damage : The worker ants forage and attack the cuttings under mud covering. They feed on bark and some times due to continuous feeding the stem is girdled and the plant completely

Control : Incorporate 60 gm of Dieldrin 5% dust or 100 gm of BHC 10% dust around the plant

(2) Chaffer beetles (*Oxyctetonia versicolor* Fabr. and *Adoretus versutus* H)

They are medium to small sized beetles. Nocturnal in habit.

Nature of damage : The adults come after dusk and bite the leaves irregularly The grubs of the beetles feed on the root portion of the plant



Control For the control of grubs in the soil the measures taken for the control of white ants will hold good. For the control of beetles feeding on leaves spray Sevin 50 WP (carbaryl) at 4 gm per litre of water.

(3) Red scales (*Aonidiella auranti* (Necost))

Small roundish red scales thickly infest the stem and thicker branches.

Nature of damage The crawlers settle on the branches and suck sap continuously. The attacked plants become weak and in severe cases branches or the entire plant may wither.

Control Spray Metacid 50 EC (methyl parathion) at 2 ml or Nuvacron 40 EC (monocrotophos) 1.5 ml per litre of water.

(4) Aphids (*Macrosiphum rosaeformis* D.)

This plantlice is pinkish or reddish in colour.

Nature of damage: They colonise on tender shoots, leaves and flower buds. Both nymphs and adult suck sap. The leaves and petals twist or curl and the buds fail to open.

Control Spray Metasystox 25 EC (oxydemeton methyl) at 1 ml or Nuvacron 40 EC (monocrotophos) at 0.75 ml per litre of water.

(5) Thrips (*Rhipophorothrips cruentatus* Hood)

Minute black insects with fringed wings infest the leaves, buds and flowers.

Nature of damage The thrips rasp the surface of the leaf or bud and feed on the oozing sap. The leaves show silvery patches and black spots appear on the surface. The petals turn brown and the flowers may not open.

Control Same as for aphids.

(6) Jassids (*Amrasca* spp.)

(Refer under okra)

(7) Red spider mite (*Tetranychus* spp.)

(Refer under citrus).

(8) Leaf cutting bees (*Megachile anthracina* S.)

These bluish green bees are moderate sized, stout bodied, densely haired and solitary in nature.

Nature of damage. They carry the bits of cut leaves (half moon shape) into their nests for lining the beds for young ones.

Control: These insects are pollinators, hence control measures are not necessary. If however their population is high Sevin 50 WP (carbaryl) at 4 gms per litre of water may be sprayed

(ii) Pests of chrysanthemum

(1) Aphids (*Macrosiphoniella sanborni* (Gill)) Small sucking insects of pinkish or greenish colour

Nature of damage They suck sap from leaves and buds. The attacked plants remain stunted and buds do not open normally

Control Same as for rose aphid

(2) Thrips (*Haplothrips lamakrishnae* K.)

They are small black insects with fringed wings

Nature of damage. They rasp the plant surface and feed on the oozing sap. The attacked parts look as if they are diseased

Control. The measures taken for the control of other insects help in checking the populations build up (refer under roses)

(3) *Capsid bug*

These are sucking insects.

Nature of damage They pierce their mouth parts into the tissue of leaves, buds and tender stems and suck the sap. the attacked parts get discoloured at such spots and dry up.

Control. The measures taken for the control of aphids help in checking the population build up of this pest

(4) *Leaf miners.*

Small moths the larvae of which act as leafminer.

Nature of damage. The larvae tunnel the leaf below the epidermis in zig-zag manner. The attacked leaves become distorted and curl up. The injury by the miner predisposes the plants to other pathogenic microorganisms

Control. Spray Nuvacron 40 EC (monocrotophos) at 1 ml per litre of water

(5) Mites (*Tetranychus* sp.)

These reddish mites feed generally on the undersurface of the leaves or florets

Nature of damage The mites suck sap from buds, florets etc. The buds fail to open fully. Damaged side gets stunted and petals do not come out.

Control Spray Kelthane 18 EC (dicofol) at 1.5 ml per litre of water.

(6) Nematode (*Meloidogvne incognita*)

These are tiny worms, live in soil.

Nature of damage The nematodes attack the roots. They form galls and hamper the development of root system of the plant. The attacked plant becomes stunted.

Control Pre-plant applicational of Furadan 3 G (carbofuran) at 33 kg/ha or Desanit 5 G (fensulfothion) at 20 kg/ha or Temik 10 G (aldicarb) at 10 kg/ha is necessary in nematode infested fields.

(iii) Pests of Jasmine

(1) Thrips (*Isoneurothrips orientalis*)

These are small insects with fringed wings.

Nature of damage Like other thrips these insects rasp and suck the oozing sap from buds and flowers. The attacked buds may not open.

(2) Mealy bugs (*Phenacoccus ornatus* Gr.)

Pinkish small insects with white cottony covering on the body.

Nature of damage They infest the stems and tender parts and suck sap and excrete honey dew on which black sooty mould develops which hampers the photosynthetic activity of the plant.

Control For mealy bugs we should depend upon biological control as given under citrus in this IM.

(3) Mites (*Tetranychus* sp.)

(Refer other mite pests)

(4) Gallmites (*Aceria jasmini* sp. n.)

Small white mites visible under microscope. Some times appear in serious forms.

Nature of damage These mites cause rust like erineum on the leaves. Flower buds get deformed.

Control Spray Kelthane 18 EC (dicofol) at 1.5 ml or Rogor 30 EC (dimethoate) at 2 ml per litre of water.

(iv) Pests of croton

(1) Mealy bugs (*Planococcus citri* Risso)

These are small pinkish insects covered with white cottony material.

Nature of damage : These insects are very common pests of croton. The young ones called crawlers settle at the midrib of the leaves and at growing tips. They continuously suck the plant sap and weaken the plant. Sometimes the plants are killed outright.

Control: For the control of mealybug, an effective biological control method is available (Refer under citrus and Biological control of mealybugs).

(2) Mites (*Tetranychus* sp.)

(Refer other mites in this IM)

(3) Thrips (*Heliothrips haemorrhoidalis*)

(Refer other thrips in this IM)

(v) Pests of other ornamental plants

Marigold is attacked by leaf-hopper (*Amrasca* sp.) and slugs (*Limax* sp.). On crosandra we frequently find mealy scale, (*Orthezia insignis*), termites (*Odontotermes obsus*), thrips and nematodes (*Meloidogyne* sp.). Aster is frequented by hairy caterpillars, beetles and mealy bugs, Dahlia by aphids, thrips, tarsonemid mites (*Polyphagotarronemus*), Tuberose by thrips and scale insects, Hibiscus by thrips, aphids, black scale and weevil, Bougainvillea by caterpillars, beetles and soft scale, and gladiolus by thrips, mites and bollworm (*Heliothis armigera*). Some of these pests may become serious under certain conditions.

For the control of sucking insects Matasystox, Nuvacron, for leaf-feeding insects Sevin, Ekalux, Cythion and Matacid can be used if necessary. Do not use insecticides indiscriminately, some time cutting the affected shoot can solve the problems

4.3 Precautions

Refer under fruit and vegetable pests)

4.4 Materials required

(Refer under fruit and vegetable pests).

4.5 Procedure

(Refer under fruit and vegetable pests).

4.6 Observations

(Refer under vegetable pests).

4.7 Calculations

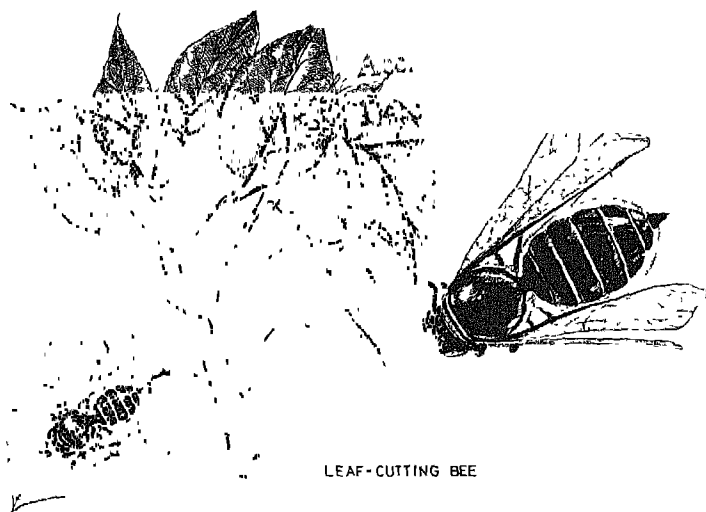
(Refer under fruit and vegetable pests).

4.8 Expected behavioural outcome

(Refer under fruit and vegetable pests).

4.9 Questions

- (i) Name the common insect pests of roses, Chrysanthemum, Jasmine and Croton.
- (ii) What control measures are suggested against rose chaffer beetle, red scale, thrips, mites, nematodes and croton mealy bug?
- (iii) If you know the active ingredient of insecticide how you will calculate insecticide water ratio?
- (iv) How you will calculate the effectiveness of control measures organized?



LEAF-CUTTING BEE

DISEASE CONTROL IN FRUIT CROPS

5.1 Instructional objectives

The pupil should be able to

- identify the disease ;
- anticipate the incidence of disease depending upon the changes in weather conditions ,
- take measures to prevent the spread of the disease ;
- estimate the losses caused ,
- understand nature and extent of damage ;
- organise control measures ,
- understand the use of application equipment

5.2 Relevant information

- *What is a disease?*

All deviations from the normal in structure and/or function constitute disease .

- *Symptoms of disease*

External/internal signs of abnormality on the plant which are characteristic of a given disease are known as symptoms

- *Cause of disease*

Microscopic organisms like fungi, bacteria, viruses, nematodes, mycoplasma, rickettsia are mainly, responsible for causing various types of diseases in plants. Deficiency or excess of some elements is also exhibited in the form of signs similar to disease symptoms. Diseases develop following specific predisposing factors.

- *Predisposing factors .*

Changes in climatic/ weather factors like relative humidity and temperature, etc play important role for the development of disease.

— *Types of disease*

Different plants suffer from different types of diseases. Some diseases are common in many plant species. Diseases of important plants are given here

(i) *Mango diseases*

Fungal

1. Powdery mildew (*Oidium mangiferae*)
2. Anthracnose (*Colletotrichum gloeosporioides*)
3. Pink disease (*Pellicularia salmonicolor*)
4. Sooty mould (*Meliola mangiferae*, *Capnodium* sp.)

Bacterial

5. Leaf spot (*Pseudomonas mangiferae indicae*)

Unknown

6. Malformation

For control of powdery mildew disease spray the crop with wettable sulphur (0.2%) at fortnightly intervals and destroy the infested leaves

For control of anthracnose and powdery mildew, spray the tree with Bavistin (0.1%) at 15 day interval. Instantaneous dips of fruit in Bavistin, Banomyl or TBZ (1000 ppm) before storing them also controls the anthracnose of fruits.

(ii) *Citrus diseases*

Viral

1. Tristeza—spreads by vectors like *Aphis citricidus* and *Toxoptera citricida*.
2. Psorosis
Mycoplasma like bodies

3. Greening—spreads by vector—*Diaphorina citri*

Fungus

4. Root rot (*Phytophthora parasitica* Dast., *Phytophthora palmivora* Butler)
5. Gummosis (*Phytophthora* sp.)
6. Powdery mildew (*Oidium tingtonium* Carter)

Bacterial

7. Canker (*Xanthomonas citri* (Hase) (Dowson)

Deficiency

8. Zinc, nitrogen, boron, iron, calcium, manganese and copper

Disease problems can be checked by following clean cultivation, sanitation, soil management and periodic spray with copper fungicides (0.25%), streptomycin sulphate (500 ppm) and dithane

m 45 (0.25%) Trunk pasting with 'Bordeaux' paste be done occasionally The nematode can be controlled by application of aldicarb or carbofuran at 4 kg active ingredient per hectare. For overcoming 'Tristeza' virus problem in acid lime, plants may be protected by use of mild strain of virus (cross protection)

(iii) *Banana diseases*

1. Panama wilt (*Fusarium oxysporum* f. sp. cubense)
2. Leaf spot (*Cercospora musae*)
3. Anthracnose (*Gloeosporium musarum*)
4. Mako disease/ Bacterial wilt (*Pseudomonas solanacearum*)

Sowing of resistant varieties if available and cultural practices help control of these disease.

(iv) *Guava diseases*

Fungal

1. Wilt (*Fusarium oxysporum* f. psidii)
2. Scab (*Pestalotia psidii*)
3. Fruit rot (*Phytophthora picotianal* var. *parasitica*)

Bacterial

4. Stem Canker (*Phyalospora psidii*)

For control of fruit rot, apply zineb (0.2%) and Aureofungin (10 ppm) at monthly interval from June to November

(v) *Sapota diseases*

- a. Leaf spot (*Phaeophleospora indica* *Pestalotia* sp., *Glomerella cingulata*)
- b. Leaf blight (*Fusicoccum sapoticola*)
- c. Flat limb (*Botryodiplodia theobromae*)

Among the three fungal diseases mentioned, leaf spot is most serious. For the control of this disease spraying with Dithane Z-78 (0.2%) is quite effective.

(vi) *Grape diseases*

Fungal

1. Downy mildew (*Plasmepara viticola* Berl and detony)
2. Powdery mildew (*Uncinula necator* (Schw.) (Buron)
1. Anthracnose (*Gleosporium ampelphagum* (do Baty) Sacc.)

For control of downy mildew, destroy diseased twigs Spray vine with Bordeaux mixture (5:5:50) immediately after pruning and at 15 days interval. Anthracnose could be effectively controlled by spraying Difoltan (0.2%).

(vii) *Papaya diseases*

Viral

1. Mosaic
2. Leaf curl

Fungal

3. Foot rot (*Pythium aphanodermatum* (Edson.) Fitz.)
4. Powdery mildew (*Oidium caracae*)

Periodic spray with systemic insecticide and sulphur fungicide checks the diseases. For foot rot disease follow clean cultivation and cultural practices

(viii) *Pomegranate diseases*

1. Fungal leaf spot (*Cercospora punicae*)
2. Die back (*Phyllosticta* sp.)
3. Bacterial leaf spot (*Xanthomonas punicae*)

Spray streptocycline and zineb for control of these diseases.

5.3 Precautions

- Keep close watch on disease appearance
- Apply control operations immediately after disease appearance
- Follow recommended dosages of spray chemicals

5.4 Material required

- Fungicides, sprayers, dusters, containers, measuring cylinders and balance for weighing chemicals

5.5 Procedure

— *Cultural practices*

- i. Deep and repeated ploughing in summer months.
- ii. Keep fields clean by burning crop stubbles, removing weeds and border plants
- iii. Prune out diseased twigs/shoots

— *Spray operation*

- i. Choose suitable sprayer with appropriate nozzle. Knapsack or hyjet sprayer for field crops, ornamental crops and compressor or power sprayer for fruit crops are good.
- ii. Check various parts of the equipment and their working one day before the operation. Do oiling and greasing whenever needed before and after spraying
- iii. Prepare spray suspension in suitable containers and filter the suspension through muslin cloth or strainer

- iv. Spray the suspension thoroughly on crop at high pressure to cover the full leaf area

5.6 Observations

- The pupil should record the disease symptoms after treatment
Field/general appearance comparison of treated and untreated crops may also be done

5.7 Calculations

- Calculate the time taken in spraying by different sprayers in terms of man power needed for the operation

5.8 Expected behavioural outcome

The pupil acquires the following abilities to

- use the equipment for control of the diseases ,
- learn the control operations to be done in the field and compare the cost with benefit

The teacher should evaluate the pupil for the above abilities

5.9 Questions

- (i) When you shall start the control operation?
- (ii) What and how one should use the operation equipment?

PREPARATION AND APPLICATION OF BORDEAUX PASTE AND BORDEAUX PAINT ON FRUIT TREE

6.1 Instructional objectives

The pupil should be able to

- prepare Bordeaux paste and paint ,
- apply it on fruit trees

6.2 Relevant information

- *What is Bordeaux paste?*

It is 'Boreaux mixture in a paste form. It acts for a very long period to check the pathogen

- *Why to apply Bordeaux paste?*

The paste helps checking the disease causing organisms mainly soil borne pathogens to come in contact with stem of the plant

6.3 Precautions

- Do not prepare Bordeaux paste in container made of metal.
- Apply it immediately after preparation. It should not be stored for longer time

6.4 Materials required

- (i) Buckets/drum of 20 litres size.
- (ii) Copper sulphate @ 1 kg/20 litres of water.
- (iii) Lime @ 2 kg/20 litres of water
- (iv) Muslin cloth 1 metre
- (v) Brush 5-10 cm size

6.5 Procedure

(a) *Bordeaux paste*

- Mix copper sulphate, 1 kg in 10 litres of water. Stir well for some time.
- Mix 2 kg lime in 10 litres of water in separate bucket
- Strain both suspensions through muslin cloth one after another in third bucket
- Dip litmus paper strip to test acidity of the mixture (red colour shows acidity)
- Add lime suspension till the red colour of the litmus paper goes away,
- Apply the paste immediately with the help of a brush. The paste be applied on trunk and cut branches of trees

(b) *Bordeaux paint*

Mix one part of monohydrated copper sulphate, 2 parts of lime and 3 parts of boiled linseed oil (Monohydrated copper sulphate, an amorphous white powder is obtained by heating the dry copper sulphate crystals)

Mix lime powder and monohydrated copper sulphate powder well and then add boiled linseed oil

Mix them thoroughly and store in a closed vessel. Apply with a brush to protect the wounds from the wood-rotting fungi specifically in heavy rain-fall areas

6.6 Observations

The pupil should record

- Colour of the litmus paper
- Consistency of the paste.
- Whether the mixture settles down in the bottom of bucket when stored for longer time
- Whether the paste sticks to the trunk of tree,

6.7 Calculations

- Calculate the number of plants which are pasted with 20 litres of paste
(One plant needs 100-200 ml suspension)

6.8 Expected behavioural outcome

The pupil acquires the following abilities to

- prepare Bordeaux paste ,
- prepare Bordeaux paint ,

- apply them on fruit trees ,
- calculate the amount of paste required for pasting one trees.

The teacher should evaluate the pupil for the above abilities

69 Questions

- (i) Why 'Bordeaux paste' should not be prepared in metal container ?
- (ii) What is the quantity of copper sulphate and lime needed for pasting citrus trees in one hectare area?

DISEASE CONTROL IN VEGETABLE CROPS

7.1 Instructional objectives

The pupil should be able to

- identify the disease and anticipate the incidence of disease depending upon the changes in weather conditions;
- estimate the extent of damage and losses caused,
- take measures to prevent the spread of the disease;
- do different control operations;
- produce disease free seed and planting material.

7.2 Relevant information

- "Prevention is better than cure" This saying proves more true with vegetable diseases
- Conditions most congenial to plant growth are also suitable to the organisms that cause disease
- Numerous diseases that appear in vegetable crops are easy to control provided their source and origin is known in advance
- Most of the vegetables commonly grown in India belong to a few common families. Thus a disease affects a number of crops in the same family.
- Vegetable crops are grown all the year round, continuously or one after another. So the disease, once occurred, remains there for long. Such disease acquires epidemic form as and when favourable conditions for it develop

Classification of diseases on the basis of origin

(i) *Seed borne diseases*

(a) **Externally seed-borne**

Disease organism remains on seed surface eg Leaf spot,

fruit rot, stem gall of coriander, purple blotch disease of onion/garlic etc

(b) Internally seed-borne

Disease organism remains inside seed or its embryo eg black rot of crucifers, bacterial wilt of *solanaceous* crops, late blight of potato, etc.

- (ii) *Soil-borne diseases* Disease harboured in soil. The pathogenic organisms remain in soil alone or in crop stubbles and crop left-overs eg bacterial wilt of solanaceous crops, damping off, root-knot, downy mildews, powdery mildews, stem gall of coriander, root rot and wilt diseases
 - (iii) *Air-borne diseases* Diseases whose pathogenic organisms are found in air in some forms either along or sticking to soil particles eg, late and early blights of potato, downy and powdery mildews, leaf spot and rust diseases
 - (iv) *Insect-borne diseases* Diseases harboured or carried by insects eg virus diseases like mosaic and little leaf and bacterial wilt disease in banana.
 - (v) *Water-borne diseases* Diseases which are carried and spread through rain or irrigation water eg late blight and bacterial wilt in potato, root-knot, damping off, stem gall of coriander and black rot of cauliflower diseases.
- *Spread of diseases* : Once a single plant becomes diseased the pathogenic organism multiplies fast and spreads to the surrounding plants. Agencies like rain, air, man, animals and insects help in spread of such diseases

7.3 Precautions

- Follow plant quarantine procedure for handling the propagating nits of vegetable crops
- Follow strict sanitary and cultural practices if some disease has occurred in the surrounding area.
- Assure planting of disease free certified seed.
- Apply chemical sprays as per recommendations.
- Prepare in advance and arrange all materials needed for disease control

7.4 Materials required

- i. Fungicides, antibiotics, formaldehyde etc
- ii. Sprayer, duster, injector, seed dresser ect
- iii. Buckets, brush, strainers, litmus paper, measuring cylinder,

balance

iv Chemicals like copper sulphate, lime, soap etc

7.5 Procedure

— Clean cultivation

Prepare field in such a way that roots, trashes, stubbles and other left-over of previous crop along with weeds are destroyed. Keep the bunds, path and surroundings of the field clean.

— Roguing :

Uproot and burn the unproductive diseased plants. Destroy the diseased material falling on ground.

— Surgery .

Remove diseased older leaves. Cut and destroy plant parts in the first stage of disease or as soon as the disease is seen on one or two leaves.

— Spraying (a type case)

Disease
Diagnostic
symptoms

Churda-murda of chilli

- i) Death of apical and axillary buds
- ii) Growth stops at any stage of crop
- iii) Top portion of the plant shows bunching due to reduction in leaf and internode size and leaf curling. Leaves become brittle.
- iv) Lower surface of leaves show brownish and shining deposition.

Spray
material

- i) Sulfex-2.5 kg/litre
 - ii) Rogor 1ml/litre
 - iii) Teepol 1ml/litre
- Mix measured quantity of all the three in required volume of water. Prepare spray solution just before spraying.

Schedule of
spray

- A. **Preventive**
- i) Spray once in nursery
 - ii) Repeat spray after one month of planting

- iii) Follow fortnightly spray till flowering.

B Curative

- i) Spray as soon as the disease is seen in a few plants.
- ii) Repeat spray twice at weekly interval

76 Observations

The pupil should

- Observe the fresh growth coming in treated plants ;
- compare the rate of growth in plant as per age ;
- record yield in treated and untreated plots

77 Calculation

- Calculate the cost per spray
- Calculate total cost of all sprays for effective control of the disease
- Calculate the increase in yield and its market value.
- Work out cost-benefit ratio.

78 Expected behavioural outcome

The pupil acquires the following abilities to

- identify the disease ;
- start control operations ,
- control or minimise a disease in field;
- save crop losses due to diseases

The teacher should evaluate the pupil for the above abilities

79 Questions

- (i) Why it is necessary to control a disease?
- (ii) What measures be combined in order to control a disease?
- (iii) What are the sources of diseases in vegetable crops?

CONTROLLING DAMPING OFF OF SEEDLINGS

8.1 Instructional objectives

The pupil should be able to :

- know the measures taken for control of the disease;
- do different operations necessary;
- know stage as which these operations are to be done.

8.2 Relevant information

- *What is damping off of seedlings?*

Damping off disease is caused by fungi inhabiting the soil. It is a serious disease particularly in crops which are raised through seedlings. Main crops affected include tomato, brinjal, chillies and crucifers.

The disease may affect the seedlings in nursery bed as soon as they emerge out. The basal portion of stem along with roots collapses and plant falls on the ground. In a nursery bed the disease may start in patches and soon the entire lot of seedlings dies.

- *What operations are needed for the control?*

Depending upon the life-cycle of the pathogen, soil treatment, seed treatment and seedling treatment (soil drench) are necessary for control of the disease.

- *What are the weather conditions when the disease develops fast?*

The disease appears immediately after the onset of monsoon rains when weather conditions are most conducive (80-100% relative humidity and 20-30°C temperature).

8.3 Precautions

- Do not sow seedlings of the same crop repeatedly in the same field.

- Grow nursery after soil and seed treatment
- Follow ideal cultural practices in preparing beds
- Observe nursery beds keenly every day and apply seedling treatment immediately as soon as you see a few seedlings diseased

8.4 Materials required

- i *For soil treatment :*
Injector, Formaldehyde or any other fumigant, heating unit, trashes or straw for burning.
- ii *For seed treatment :*
Fungicides like Dithane M-45, Thiram, Captan, Benomyl, Bavistin, Brassicol etc , and antibiotics like Agrimycin and Streptocycline
- iii *For seedling treatment or soil drench*
Captan, Dithane M-45, Brassicol and Bavistin.
- iv Plastic buckets and water.

8.5 Procedure

- *Soil treatment*
 - a) Burn trashes/straw and stubbles on soil of the bed.
 - b) Deep ploughing (10-15 cm deep) for 4-5 times during summer months.
 - c) Apply formaldehyde (diluted 4 times) to a depth of 10 cm with the help of injector. Cover the bed with polythene sheet for 6-15 days. Then turn the soil before sowing seeds
- *Seed treatment*
 - a) Treat the seeds before sowing with suitable fungicide @ 1-5 g/kg seed
 - b) Mix well the fungicide with seeds in a seed treating drum/nylone bag or an earthen pot
 - c) Sow seeds immediately after treatment.
- *Seedling treatment or soil drench*
 - a) Prepare 0.2% solution of Captan, Thiram, Brassicol or 0.05% solution of Bavistin
 - b) Pour the fungicidal suspension on soil surface in a nursery bed till it floods
 - c) Do not irrigate the beds for 2-3 days after drenching

8.6 Observations

The pupil should record the following information .

- i. Physical condition of the soil of the bed. (Soil of the bed

becomes pulverised and dry)

- ii. Germination of seeds
- iii. Diseased seedlings if any Count them and compare with that of untreated nursery bed

8.7 Calculations

- Calculate the quantity of formaldehyde for soil treatment @ 10 ml/sq-metre of soil
- Calculate the quantity of fungicides for treating seeds to be sown in one hectare field @ 300 g/ 100 kg seed
- Calculate the quantity of fungicidal suspension for drenching a nursery bed of 2m x 1 m size @ about 10-20 litres suspension/sq.metre

8.8 Expected behavioural outcome

The pupil acquires the following abilities to

- take appropriate measure for soil, seed or seedling borne diseases ,
- do soil treatment, seed treatment and soil drenching,
- adopt cultural practices for minimising the disease

The teacher should evaluate the pupil for the above abilities

8.9 Questions

- i) What operations are required for controlling damping off disease in seedlings?
- ii) What chemicals are needed for seed, soil or seedling treatment?
- iii) In which season of year the seedling in nursery are affected by damping off very seriously?
- iv) Is a nursery in saline soil is more prone to damping off than that in normal soil?
- v) Does soil pH affect the manifestation of damping off on the seedlings?

DISEASE CONTROL IN ORNAMENTAL CROPS

9.1 Instructional objectives

The pupil should be able to .

- understand different types of disease problems in ornamental crops ,
- conduct operations for control of the diseases ;
- obtain and use disease free planting material.

9.2 Relevant information

- Movement of planting material of ornamental crops is very frequent
- There are several diseases which affect these crops. Single type of disease may affect a number of related plant species. Different types of diseases which mainly occur in ornamentals are grouped as under

(i) *Leaf spot* Necrotic (dead tissues) spots of different colour, shape and size appear on leaves which may extend to twigs in some cases. The examples are chrysanthemum leaf spot (*Septoria chrysanthemi*), Jasmine leaf spot (*Cercospora jasminicola*) and marigold leaf spot (*Alternaria tagetica*)

(ii) *Blight or blast* . Due to severity of infection the leaves and in some cases twigs also are killed suddenly giving burnt appearance to the plants

(iii) *Powdery mildew* Appearance of white powdery mass mostly on upper surface of leaf. Leaves fall prematurely or become yellowish with low photosynthetic ability. Examples . Rose powdery mildew (*Sphaerotheca pannosa*), marigold powdery mildew (*Erysiphe cichoracearum*)

(iv) *Damping off of seedling* Seedlings in early age particularly after onset of monsoon season fall on ground due to rot of basal stem near the ground. Spread of the disease is so fast that the whole lot of a nursery bed is killed within a day or two.

(v) *Wilt* Plants in later age dry up with or without yellowing of foliage. Transpiration is also affected resulting in weak physiology of the plant. Example Asterwilt (*Fusarium* sp. and *Sclerotium foliosi*).

(vi) *Mosaic* Colour variation in foliage due to uneven development of chlorophyll, takes place after virus infection. Alternate light-green patches with dark green areas develop on leaves

9.3 Precautions

- Obtain disease free seeds from certified agencies only
- Keep close look on plants occasionally.
- Do control operations as soon as a disease is seen in a few plants
- Follow appropriate cultural practices.

9.4 Material required

- (i) Fungicides, antibiotics, formaldehyde etc
- (ii) Application equipment like sprayer, duster, seeddresser, injector etc.
- (iii) Plastic containers, brush, strainers, litmus paper, glass rod etc
- (iv) Chemicals like copper sulphate, lime oil, soap and chalk etc.
- (v) Seed treatment drums/pots

9.5 Procedure

Soil treatment

- Carry on deep (10-15 cm) ploughing 4-5 times during summer months.
- Fumigate nursery bed with formaldehyde (1 part in — part water)
- Burn stubbles, transhes and off type plants on the field.
- Pulverise the soil thoroughly before sowing of the seeds.

Seed treatment :

- Treat seeds with any of these chemicals Bavistin, Banomul, Captan, Thiride, Difolatan and Agrimycin

Rate 2 g/kg seed (small seeds)

3 g/kg seed (big seeds)

4 g/kg seed (light hairy seeds).

- Mix dry powder of fungicide with seed in a seed treating drum or earthen pot
- Rotate drum for five minutes to mix fungicide thoroughly.
- Sow seeds immediately after treatment. Cuttings, tubers, suckers, bulbs etc., and seedlings can be treated by dipping them in fungicide suspension of :
 - i. Systemic fungicide — 0.05%
 - ii. Non-systemic fungicide — 0.2%
 - iii. Antibiotics - - 500 ppm.

Soil drench :

- Pour fungicide suspension in nursery beds till it floods.
Repeat it after 3-5 days

9 6 Observations

- Record the germination of treated and untreated seeds.
- Observe closely the plants occasionally.
- Record rooting in treated and untreated cutting, tubers, suckers etc.

9 7 Calculations

- Calculate the number of plants survived in treated and untreated lots.
- Calculate the quantity of seeds of flowers obtained from treated and untreated lots

9 8 Expected behavioural outcome

The pupil acquires the following abilities to

- raise disease free plants ,
- control the disease incidence in garden plants ;
- obtain disease free seeds and cuttings

The teacher should evaluate the pupil for the above abilities.

9 9 Questions

- (i) How the disease damages ornamental crops?
- (ii) How to protect planting material from diseases?
- (i) What are the precautions to be taken for bringing and sending ornamental plant material?

USING A SPRAYING EQUIPMENT

10.1 Instructional objectives

The pupil should be able to

- acquaint himself about various types of sprayers, their working use and care ,
- undertake the operation with minimum expenditure and more benefit.

10.2 Relevant information

Spray

Liquid under high pressure (5-20 kg per sq cm) is ejected through a minute passage of the nozzle in the form of small dropets (5-50 u in diameter) which fall on the leaf surface

Types of spraying

- a. **High volume spraying** : Spraying which is done at low pressure thus requires large volume to cover a given area of crop
- b. **Low volume spraying** : Spraying which is done at high pressure, thus requires low volume to cover a given area of crop

Sprayer .

Equipment used for spraying is called sprayer There are various types of sprayers depending upon the crop and purpose e g automizer sprayer, Knapsack, Bakpak, Gator, Riching, Footsprayer, ULV sprayer, hyjet, power, aircraft and air blast sprayer

Parts of a knapsack sprayer :

See figure for different parts and their position

Working of a knapsack sprayer

Liquid filled in the tank is compressed by air pressure created by a pump. The liquid under pressure then escapes through a delivery hose lance and reaches to nozzle. Minute pore in the nozzle and its valve help the liquid to convert in small droplets which fall on the leaf surface.

Use of a knapsack sprayer :

- Check various parts.
- Oil and grease them before and after use.
- Prepare fungicide solution in a plastic bucket by dissolving weighed quantity of fungicide (first in small volume).
- Filter through muslin cloth
- Rinse the tank of the sprayer with water before filling it with spray liquid
- Fill the liquid in tank through the filter cap
- Operate the pump by moving the handle and plunger rod (check the leather washer, oil it if needed).
- Check the air pressure through the pressure gauge
- When the required pressure (3 kg/sq. cm) is reached, operate the trigger to allow spray drops through the nozzle

Care of spray equipment :

- Check different parts of the sprayer periodically and apply oil and grease to them
- Use clean water for preparing spray fluid
- Empty the spray tank completely before stopping the sprayer
- Do not keep the nozzle on land with the top down
- Occasionally clean nozzle and its valve.
- Replace different gaskets in case of leakage of spray liquid.

10.6 Observations

The pupil should observe

- Size of the droplet ,
- coverage of leaf area ,
- position of the nozzle/lance for spraying on both surface of leaf and different parts of plant

10.7 Calculations

Calculate the operation cost of a knapsack sprayer by

- a. adding cost of fungicide ;
- b. cost of manual labour ,
- c. accessories needed, for covering a given area of crop

10.8 Expected behavioural outcome

The pupil acquires the following abilities to

- understand a spray equipment, its parts, use and care ,
- undertake spray operation efficiently

The teacher should evaluate the pupil for the above abilities.

10.9 Questions

- (i) What you shall do if the spray equipment has stopped working during use?
- (ii) What type of equipment you should select for fruit/ vegetable crops?

APPENDIX

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